MATERIALS BUREAU

** Interim **

Materials Method 5.16
SUPERPAVE
Hot Mix Asphalt
Mixture Design and
Mixture Verification Procedures

** Interim **

NEW YORK STATE DEPARTMENT OF TRANSPORTATION

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MATERIALS BUREAU ALBANY, NY 12232-0861

MATERIALS METHOD

Materials Method No.: NY 5.16 M

Issue Date: February 28, 1997
Subject Code: 7.42-1

SUBJECT: SUPERPAVE HOT MIX ASPHALT MIXTURE DESIGN AND MIXTURE VERIFICATION PROCEDURES

APPROVED: ______________________________

Wayne J. Brule, Director, Materials Bureau

Supersedes: MM 5.16 M
Dated: February 29, 1996

PREFACE

It is the purpose of Materials Method 5.16(M) to describe NYSDOT requirements and policies in developing SUPERPAVE Hot Mix Asphalt (SHMA) mixture designs. This method lists the responsibilities of both the SHMA Producer and the Department for compliance. Specific testing details and evaluation procedures are also contained. Conformance with Materials Method 5.16(M) will assure uniform testing and evaluation of paving mixtures through volumetric analysis of laboratory and plant prepared specimens. Multiple Job Mix Formula's (JMF) to address various SUPERPAVE compaction levels may be submitted from a single design by back calculating to the appropriate specimen heights. The JMF will stay in effect as long as the aggregates used in the mixture design stay constant and acceptable volumetric properties are maintained during routine production.

The purpose of the SUPERPAVE Hot Mix Asphalt mixture design program is to design SHMA mixtures that achieve the fundamental volumetric properties needed to result in maximum pavement performance. It is extremely important that the plant quality control procedures outlined in Materials Method 5(M) "Plant Inspection of Bituminous Concrete" or the SHMA Producers Quality Control Plan (which ever is applicable) be followed to insure uniform production of the designed SHMA.

Department personnel may suggest methods for improving a mixture design to a SHMA Producer, but such suggestions do not bind NYSDOT to accepting material outside of the specifications.

***Note:** The SHMA Producer is responsible to insure that the specified criteria in the contract documents, specification, and addendum are met. The criteria in this Materials Method is presented for the convenience of the SHMA Producer and are correct as of the issue date.*

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I. SCOPE

This Materials Method describes the responsibilities and procedures for the development and review of SUPERPAVE (an acronym for SUperior PERforming asphalt PAVEments) Hot Mix Asphalt (SHMA) mixture designs. The method outlines a complete procedure for the uniform design of mixtures having an aggregate nominal maximum size not exceeding 37.5 mm.

II. GENERAL

The SUPERPAVE Hot Mix Asphalt mixture design procedure is used to establish proper proportions of aggregates and performance graded binder (PGB) to meet the mixture volumetric properties contained in the specifications. In addition, the design procedure develops the design PGB content for the selected job mix formula aggregate gradation.

The SHMA Producer is responsible for preparing the SUPERPAVE Hot Mix Asphalt design; NYSDOT is responsible for checking the submitted mixture design for completeness and accuracy. The Regional Director or their representative is the final approving authority.

A complete SHMA mixture design is required for each aggregate source combination, each aggregate gradation, and each plant utilizing the same aggregate materials at a site having multiple plants. However, the Regional Director or their representative may waive the requirement for separate mixture designs for multiple plants using the same materials providing that the aggregate gradation meets the job mix formula and the SHMA Producer can demonstrate by abbreviated volumetric tests on actual mix produced in the plant that the mixture volumetric properties are within the specified criteria.

III. INFORMATION SOURCES

The following list references the various sources of information that must be consulted in preparing a SHMA Mixture Design (in addition to this Method).

1. NYSDOT Standard Specifications - including all addenda and the project proposal.
2. NYSDOT Approval List - Sources of Fine and Coarse Aggregates.
3. NYSDOT Materials Method 5(M) - Plant Inspector's Manual for Bituminous Concrete Mix Production.
4. AASHTO T11 - Materials Finer Than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing.
5. AASHTO T27 - Sieve Analysis of Fine and Coarse Aggregates.
6. AASHTO T84 - Specific Gravity and Absorption of Fine Aggregates.
7. AASHTO T85 - Specific Gravity and Absorption of Coarse Aggregates.
8. AASHTO T100 - Specific Gravity of Soils.
9. AASHTO T166 - Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens.
10. AASHTO T176 - Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.
11. AASHTO T209 - Maximum Specific Gravity of Bituminous Paving Mixtures.
12. AASHTO T228 - Specific Gravity of Semi-Solid Bituminous Materials.
13. AASHTO T245 - Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.
14. AASHTO T283 - Resistance of Compacted Bituminous Mixtures to Moisture Induced Damage.
15. AASHTO PP2 - Short and Long Term Aging of Hot Mix Asphalt.
16. AASHTO TP4 - Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the SHRP Gyratory Compactor.
17. AASHTO TP33 - Uncompacted Void Content of Fine Aggregate (As Influenced by Particle Shape, Surface Texture, and Grading) - Method A.
18. AASHTO PP19 - Volumetric Analysis of Compacted Hot Mix Asphalt (HMA).
19. AASHTO MP2 - SUPERPAVE Volumetric Mix Design.
20. AASHTO PP28 - Designing SUPERPAVE HMA.
21. AASHTO MP1- Performance Graded Asphalt Binder.
22. Pennsylvania Department of Transportation Test Method No. 621 - Determining the Percentage of Crushed Fragments in Gravel.
23. ASTM D4791 - Flat and Elongated Particles in Coarse Aggregates

All NYSDOT listed references are available from the New York State Department of Transportation. Contact the Regional Materials Engineer for further information.

All AASHTO listed references are available from the American Association of State Highway and Transportation Officials at the following address:

American Association of State Highway and Transportation Officials
444 North Capitol Street, NW
Suite 225
Washington, D.C. 20001
Phone: (202) 624-5800

All ASTM listed references are available from the American Society for Testing and Materials at the following address:

American Society for Testing and Materials
1916 Race Street
Philadelphia, Pennsylvania 19103-1187
Phone: (215) 299-5400

IV. DETAILS OF RESPONSIBILITY

A. PRODUCER

The SHMA Producer is responsible for furnishing the Department a complete SHMA mixture design for the specified mixtures in accordance with the procedures outlined in this method. The resultant mixture volumetric properties must meet the specified mixture volumetric criteria contained in the standard specifications, addenda, or project proposal.

The SHMA Producer's responsibility includes:

1. Analysis of Plant Aggregate Gradation

The SHMA Producer shall obtain gradation data for a given mixture, and develop a target gradation meeting all control point and restricted zone criteria that the plant is capable of producing.

2. Obtaining Aggregate Samples

The SHMA Producer shall obtain representative aggregate samples in accordance with instructions outlined in Materials Method 5.0(M). A sufficient quantity of samples shall be obtained for the SHMA Producer to prepare a minimum of 14 SUPERPAVE gyratory compacted specimens and 14 maximum specific gravity samples, and a sufficient quantity for NYSDOT to prepare a minimum of 4 SUPERPAVE gyratory compacted specimens and 4 maximum specific gravity samples. A total combined aggregate weight of 130 kg should be sufficient for these purposes. The SHMA producer shall submit a sufficient sample of aggregates to NYSDOT for mixture design verification purposes as outlined in this Materials Method.

3. Job Mix Formula (JMF) Development

The SHMA Producer shall develop a Job Mix Formula (JMF) through a four step process. This process consists of the selection of the appropriate materials, the development of a design aggregate structure, the determination of a design performance graded binder (PGB) content, and the evaluation of the resultant mixture's moisture susceptibility (*at this time moisture sensitivity analysis will not be required by NYSDOT).* The SHMA Producer will be responsible for assuring that all aggregate consensus and source properties are met as well as all volumetric properties specified in the contract documents. The procedures outlined in this Materials Method shall be followed in the development of all JMFs.

4. Data Documentation

The SHMA Producer shall document the resultant test data on NYSDOT forms or NYSDOT approved computer generated forms. All forms are to be filled out and signed by the SHMA Producer. Forms required are:

BR-X1M	SUPERPAVE JMF Submittal Checklist
BR-X2B/DM	SUPERPAVE Average Washed Gradation Summary
BR-X2S	SUPERPAVE Average Stockpile Gradation Summary (Batch Plant Stockpiles / Consensus Properties)
BR-X3M	SUPERPAVE Design Aggregate Structure Consensus Property Summary
BR-X4B/DM	SUPERPAVE Design Aggregate Structure Composite Gradation Summary
BR-X5M	SUPERPAVE Design Aggregate Structure Trial Blend Gradation Plots
BR-X6M	Performance Graded Binder Temperature Viscosity Data
BR-X7M	Maximum Specific Gravity of SHMA Mixtures
BR-X8M	SUPERPAVE Design Aggregate Structure Compacted SHMA Specimen Density Worksheet
BR-X9M	SUPERPAVE Design Aggregate Structure Compacted SHMA Specimen Volumetric Property Summary
BR-10M	SUPERPAVE Batch Weights for Mixture Verification
BR-11M	SUPERPAVE Design PGB Content Compacted Specimen Density Worksheet
BR-12M	Maximum Specific Gravity of SHMA Mixtures
BR-13M	SUPERPAVE Design PGB Content Compacted SHMA Specimen Density Worksheet
BR-14M	SUPERPAVE Design PGB Content Compacted SHMA Specimen Volumetric Property Summary
BR-15M	SUPERPAVE Volumetric Property Curves
BR-XXM	SUPERPAVE Job Mix Formula (9.5 mm, 12.5 mm, 19.0 mm, 25.0 mm, and 37.5 mm as appropriate)

5. SUPERPAVE Hot Mix Asphalt Design Submission

The SHMA Producer shall submit to the Regional Materials Engineer the completed SHMA mixture design. The mixture design submission shall include the following:

- The above listed forms.
- The corresponding JMF listing the materials used, the target gradation, and production tolerances.
- The individual test data used to generate the average gradation listed.
- Sufficient PGB and aggregate samples as outlined in this Materials Method.

6. SUPERPAVE Hot Mix Asphalt Design Production Notification

After Verification Status has been assigned to the SHMA mixture design, the SHMA Producer shall give the Regional Materials Engineer 24 hours notice prior to initial production of the new mixture design. If this notice is not given mixture production may not begin.

7. SUPERPAVE Hot Mix Asphalt Production Monitoring

The SHMA Producer must monitor all volumetric properties and aggregate gradation during production to determine conformance to the specified criteria in accordance with the requirements outlined in Section 402 - Quality Control Asphalt Concrete - General.

8. Additional Test Requirements

Upon assignment of Production Status to the SHMA mixture design the SHMA Producer will establish a routine testing schedule to test the following items at the minimum frequency listed in **Table 1 - Aggregate Testing Frequency:**

Table 1 - Aggregate Testing Frequency

Test	Frequency
Coarse Aggregate Specific Gravity	One Per Three Months
Fine Aggregate Specific Gravity	One Per Three Months
Washed Gradation Analysis	One Per Week
Coarse Aggregate Angularity	One Per Three Months
Fine Aggregate Angularity	One Per Three Months
Flat and Elongated Particles	One Per Three Months
Sand Equivalent	One Per Three Months*

* *Only when required by the Regional Materials Engineer due to field performance problems.*

Note: ***Fine Aggregate Specific Gravity Testing will not be required on stone screenings and manufactured sands from crushed stone sources. The specific gravity of these materials may be assumed to be the same as the average Coarse Aggregate Specific Gravity from the same source.***

Note: ***The aggregate specific gravities that are used to determine mixture volumetric properties during mixture verification and plant production monitoring will be based on the running average of the last six tests (or less) that were performed on each source. If no previous specific gravity testing has been performed, the previously untested aggregate used in the mixture design shall be tested and the resultant values used.***

Note: ***The SHMA Producer may elect to determine the individual Coarse Aggregate Specific Gravity on a blend of materials from stockpiles (i.e., 1A's, 1's, and 2's) of the same source in-lieu of performing tests on each individual stockpile. If this procedure is used the SHMA Producer should request the appropriate Test Method from the Materials Bureau.***

B. NYSDOT

The following outlines the review of a submitted SHMA mixture design for completeness and accuracy performed by the Regional Materials Engineer.

1. Review the SHMA Design Submission

Review the JMF and associated information for accuracy and completeness in accordance with Section VII, VERIFICATION OF SUPERPAVE HOT MIX ASPHALT MIXTURE DESIGNS. Based on this review the Regional Materials Engineer will either:

- Assign Verification Status to the submitted design.

or

- Reject the submitted design for not meeting the specified mixture volumetric criteria or the consensus aggregate property requirements contained in the standard specifications, addenda, or project proposal.

or

- Determine the submitted design does not meet criteria listed in Section VII and conduct a laboratory verification. The purpose of laboratory verification is to check laboratory technique used to complete the submitted designed. At the conclusion of the laboratory verification (if required) the Regional Materials Engineer will either assign Verification Status to the design or reject it for not meeting the specified mixture volumetric criteria contained in the standard specifications, addenda, or project proposal.

2. SUPERPAVE Hot Mix Asphalt Production Monitoring

During mixture production the Regional Materials Engineer will conduct Quality Assurance testing in accordance with the requirements of §402.

3. Determination of QAFs During Production

The Regional Materials Engineer will determine the QAF to be applied to material produced and used on Department projects during Verification Status production in accordance with the requirements of Section VII. At the conclusion of the third Verification Status production day the Regional Materials Engineer will assign the design Production Status, beginning on the next production day of the particular design. If less than 2,700 cumulative metric tons is produced during the initial 3 production days, the Verification Status of the design will be extended through the conclusion of the production day that 2,700 cumulative metric tons is produced at which time Production Status will be assigned by the Regional Materials Engineer. During Production Status the Regional Materials Engineer will determine the QAF to be applied to material produced and used on Department projects in accordance with the requirements of §402.

V. SUPERPAVE HOT MIX ASPHALT DESIGN PROCEDURE

This section outlines procedures to be followed by the SHMA Producer in preparing the mixture design and by the Region Laboratory when reviewing mixture designs for volumetric and mechanical properties. Specifically, the SUPERPAVE mixture design will be developed by the

SHMA Producer in accordance with AASHTO MP2, “SUPERPAVE Volumetric Mix Design” and with PP28, “Designing SUPERPAVE HMA”. This section outlines the procedures detailed in these standards for the testing and analysis of data to establish SUPERPAVE volumetric and mechanical mixture properties and eliminates as many variables as possible to result in precise and uniform testing.

A. OVERVIEW OF THE SUPERPAVE HOT MIX ASPHALT MIXTURE DESIGN SYSTEM

The SUPERPAVE Hot Mix Asphalt mixture design system and Performance Graded Binder specification were developed as a result of research performed during the Strategic Highway Research Program or SHRP. SUPERPAVE represents a new approach to designing SHMA mixes, addressing the three principal distresses that plague HMA pavements: rutting, fatigue cracking, and low temperature cracking. SUPERPAVE is performanced based, both the Performance Graded Binder Specification and mix design system were developed to identify the performance properties needed to assure that the in-place SHMA will achieve the pavement’s design life. Specifically, SUPERPAVE HMA mixes will be designed for the diverse but specific climate and traffic conditions that they will be exposed to at projects sites across the State.

[1]The objective of the SUPERPAVE mix design system is to define an economical blend of PGB and aggregate that yields a paving mix having sufficient PGB, sufficient Voids in the Mineral Aggregate (VMA), sufficient workability, and satisfactory performance characteristics over the service life of the pavement. The SUPERPAVE design method provides a truly objective measure of the benefits or penalties associated with the use of materials of varying levels of quality.

B. SELECTION OF MATERIALS

1. Aggregate Selection / Requirements

In addition to the requirements detailed in §401-2.03 Aggregates the aggregates used in the development of a SHMA mixture design must meet additional consensus requirements for Coarse Aggregate Angularity, Fine Aggregate Angularity, Flat and Elongated Particles, and Sand Equivalent. The specific consensus property requirements for an individual project will be based on the estimated traffic loadings and detailed in the Contract Documents.

If an individual aggregate component does not meet the aggregate quality requirements specified in the Contract Documents, it is not necessarily precluded from use. However, its percentage of use in the total aggregate blend will be limited as determined by the law of partial fractions. If an aggregate component percentage is limited due to quality

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[1] Cominsky, R. J. (1994). SHRP-A-407 The SUPERPAVE Mix Design Manual for New Construction and Overlays, *Strategic Highway Research Program*, National Research Council, Washington D.C., pp.-2.

concerns, the Design Aggregate Structure selected will be evaluated to assure compliance with the aggregate consensus property requirements.

When the coarse aggregate is blended to meet the specified friction aggregate requirements, not less than 25% (by weight with adjustments to equivalent volumes for materials of different specific gravities) of the total coarse aggregate particles should be non-carbonate material as determined from the target batching percentages listed on the JMF.

Note: ***When the coarse aggregate is blended to meet the specified friction aggregate requirement, the SHMA Producer should pay particular attention to the % of non-carbonate material in the friction aggregate. If the friction aggregate being blended is less than 100 % non-carbonate, the % of the blend must be increased proportionally so that the resulting mixture contains not less than 25 % non-carbonate material in the total coarse aggregate.***

Note: ***The SHMA Producer should pay particular attention to the coarse aggregate friction aggregate requirements for 12.5 mm and 9.5 mm top courses. The friction aggregate requirements may vary from project to project depending on the traffic volumes encountered on a specific project.***

2. Performance Graded Binder Selection

A Performance Graded Binder (PG XX-YY) is defined by the range of pavement temperatures, maximum to minimum, over which the binder can be expected to provided acceptable performance. The maximum pavement temperature (XX) is defined by the average 7-day maximum pavement temperature 20 mm below the surface of the pavement layer. The minimum pavement temperature (-YY) is defined as the minimum pavement surface temperature which is equal to the minimum air temperature. Using the SUPERPAVE weather database temperature variability is accounted for and a design reliability (or design risk) is assigned for each PGB.

Note: ***The PGB used on an individual project will be specified by NYSDOT in the Contract Documents.***

Note: ***Sources of a PGB used in a mixture design may be changed during production at the discretion of the SHMA Producer. Extreme caution should be exercised when modified PGBS are being used.***

Note: ***Complete mix designs will not be required for different specified PGB grades within the same compaction level (based on the estimated traffic loading in millions of 80 kN equivalent single axel loads). However, a new JMF will have to be submitted which references the original design and shows the PGB to be used. When this is done, the mixture verification procedure detailed in Section VII will apply.***

The PGB used on State contracts will be certified to meet NYSDOT's quality requirements by a primary source appearing on the Department's Approved List of Asphalt Cement for Paving. Generally this certification should be provided by the last primary source to physically alter the PGB.

C. SELECTION OF THE DESIGN AGGREGATE STRUCTURE

In this phase of mixture design development the SHMA Producer will develop the design aggregate structure for the SUPERPAVE mixture. This will be accomplished by compacting at least three unique aggregate trial blends in the SUPERPAVE Gyratory Compactor. The test results and analysis of this data will be used to select the design aggregate structure. The specific procedures to develop the aggregate trial blends are detailed in Section VI-A "Analysis of Plant Aggregate Gradation".

The SHMA Producer will be required to submit test results and data analysis from at least three aggregate trail blends. This information will be used by NYSDOT in the analysis of the design aggregate structure selected and to propose potential adjustments to the design aggregate structure if the submitted mixture design fails to be verified.

Note: If a revision to a Production Status mixture design is required only one aggregate trial blend analysis will be required to be submitted if all of the same aggregate sources are used.

All of the trial aggregate blends submitted will be required to meet all of the aggregate quality requirements (see **Table 4 - Additional Aggregate Criteria**), the design control points (see **Table 2 - Design Control Points**), and the restricted zone (see **Table 3 - Restricted Zone**) detailed in the Contract Documents for the specified estimated traffic loads. Designs will not be considered if any of the three trial blends do not meet these requirements. No exceptions to this requirement will be allowed.

Table 2 - Design Control Points

Standard Sieves, mm	Percent Passing Criteria (*Control Points*)									
	Nominal Maximum Aggregate Size									
	37.5 mm		25.0 mm		19.0 mm		12.5 mm		9.5 mm	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
50.0		100.0								
37.5	100.0	90.0		100.0						
25.0	90.0		100.0	90.0		100.0				
19.0			90.0		100.0	90.0		100.0		
12.5					90.0		100.0	90.0		100.0
9.5							90.0		100.0	90.0
4.75									90.0	
2.36	41.0	15.0	45.0	19.0	49.0	23.0	58.0	28.0	67.0	32.0
0.075	6.0	0.0	7.0	1.0	8.0	2.0	10.0	2.0	10.0	2.0

Table 3 - Restricted Zone

Standard Sieves, mm	Percent Passing Criteria (*Control Points*)									
	Nominal Maximum Aggregate Size									
	37.5 mm		25.0 mm		19.0 mm		12.5 mm		9.5 mm	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4.75	34.7	34.7	39.5	39.5						
2.36	27.3	23.3	30.8	26.8	34.6	34.6	39.1	39.1	47.2	47.2
1.18	21.5	15.5	24.1	18.1	28.3	22.3	31.6	25.6	37.6	31.6
0.600	15.7	11.7	17.6	13.6	20.7	16.7	23.1	19.1	27.5	23.5
0.300	10.0	10.0	11.4	11.4	13.7	13.7	15.5	15.5	18.7	18.7

1. Mixture Aggregate Consensus Properties

The following aggregate consensus properties shall be determined and reported on BR-X3M "SUPERPAVE Design Aggregate Structure Trial Blend Gradation Summary".

Table 4 - Additional Aggregate Criteria

Estimated Traffic, Million 80 kN ESALs	Coarse Aggregate Angularity		Uncompacted Void Content of Fine Aggregate		Flat and Elongated Particles	Sand Equivalent
	Depth from Surface					
	<100 mm	>100 mm	<100 mm	>100 mm		
<0.3	55/-	-/-	-	-	-	40
<1.0	65/-	-/-	40	-	-	40
<3.0	75/-	50/-	40	40	10	40
<10.0	85/80	60/-	45	40	10	45
<30.0	95/90	80/75	45	40	10	45
<100.0	100/100	95/90	45	45	10	50
>100.0	100/100	100/100	45	45	10	50

Coarse Aggregate Angularity. Coarse aggregate angularity is defined as the percent by weight of the aggregate particles larger than 4.75 mm with one or more fractured faces measured on the coarse particles of the blended aggregate by Pennsylvania Department of Transportation Test Method No. 621 “Determining the Percentage of Crushed Fragments in Gravel”. Note that “95/90” denotes that 95% of the coarse aggregate has one fractured face and 90% has two fractured faces. Note that the criteria is presented as the minimum percent of coarse aggregate with the required number of fractured faces.

Fine Aggregate Angularity. Fine aggregate angularity is defined as the percent of air voids present in loosely compacted aggregate that passes the 2.36 mm sieve measured on the fine aggregate portion of the blended aggregate by AASHTO Standard Method of Test TP33 “Uncompacted Void Content of Fine Aggregate”. Note that the criteria is presented as the minimum percent air voids required in loosely compacted fine aggregate.

Note: ***When the fine aggregate angularity of a natural sand or stone screening from a crushed gravel source is evaluated, the specific gravity of the Method A blend must be determined for use in the test. When a manufactured sand or stone screening from a crushed stone source is evaluated, use the specific gravity determined from the as sampled material (if the specific gravity was assumed to be the same as the coarse aggregate from the same source use this value).***

Flat and Elongated Particles. Flat and elongated particles are defined as the coarse aggregate particles which have a ratio of maximum to minimum dimensions greater than five (5). The percentage of flat and elongated particles is measured on the portion of the blended aggregate retained on the 9.5 mm sieve by ASTM Standard Method of Test D 4791-95 "Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate". Note that the criteria is presented as the maximum percent allowed by weight of flat and elongated particles.

Note: ***The maximum dimension is defined as the particles maximum length. The minimum dimension is defined as the particles maximum thickness (i.e., if the cross section of the particle is irregularly shaped, the maximum thickness is equal to the length of the short side of a rectangle large enough to contain this shape).***

Sand Equivalent. Sand equivalent is defined as the percent of the sand reading to the clay reading measured on the portion of aggregate that passes the 4.75 mm sieve by AASHTO Standard Method of Test T 176 "Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test". Note that the criteria is presented as the minimum percent sand equivalent required in the fine aggregate.

Note: ***Determination of the Sand Equivalent is not required on a routine basis. NYSDOT believes the aggregates commonly used in New York will meet the most stringent consensus property requirement. However, if performance problems are encountered NYSDOT may require this testing to be performed.***

If any of the aggregate consensus quality requirements specified in the Contract Documents are not met for any of the aggregates used in the proposed mix design, the percentage these aggregates will be limited in the total aggregate blend as determined by the law of partial fractions as detailed below.

$$EAQ = \frac{AQ_1*PP(R)_1*PB_1 + AQ_2*PP(R)_2*PB_2 + AQ_N*PP(R)_N*PB_N}{PP(R)_1*PB_1 + PP(R)_2*PB_2 + PP(R)_N*PB_N}$$

where:

EAQ = Estimated Total Aggregate Consensus Property Quality,

AQ_N = Aggregate Consensus Property Quality (i.e., the percentage of Coarse Aggregate Angularity in a given stockpile),

$PP(R)_N$ = Percentage Passing or Percentage Retained for the specified sieve size for each stockpile,

PB_N = Blend Proportions for each stockpile.

If the estimated total aggregate consensus property quality is below that specified in the Contract Documents then the percentage batched for the failing aggregate will be reduced to bring it into conformance.

2. Estimated Trial Blend Binder Content

The trial blend PGB content shall be determined in accordance with Section 7 of AASHTO PP28, "Designing SUPERPAVE HMA". This estimated value shall be reported on BR-X7M "SUPERPAVE Design Aggregate Structure Trial blend Mixture Maximum Specific Gravity Summary" and BR-X9M "SUPERPAVE Design Aggregate Structure Trial Blend Compacted Specimen Volumetric Property Summary". If in the opinion of the mixture designer the estimated trial blend binder content is inappropriate based on experience an alternate PGB content may be used for the design aggregate structure phase of the mixture design. Care should be used in the selection of the trial blend PGB content because this point may be used in the selection of the design PGB content phase of the mixture design. Thereby, reducing the total number of specimens required to be compacted.

3. Data Analysis and Estimation of Trial Blend Volumetric Properties @ 4% Air Voids

The SUPERPAVE specimen volumetric and mechanical data will be calculated and analyzed in accordance with Section 9 of AASHTO PP28, "Designing SUPERPAVE HMA". The volumetric and mechanical properties for the compacted specimens must be estimated at a nominal 96% G_{mm} to provide a basis for comparison between the different trial blends before a design aggregate structure can be selected. Also, the estimated design PGB content will be determined for each of the trial blends. This estimation will be used to determine the four PGB contents that will be evaluated in the selection of the design PGB content phase of the mixture design.

4. Selection of the Design Aggregate Structure

Only aggregate trial blends which meet the volumetric and mechanical properties detailed in the Contract Documents, estimated at 96% $G_{mm,}$ can be selected as the design aggregate structure. If more than one of the aggregate trial blends meets all of the specified requirements the selection of the design aggregate structure will be at the discretion of the SHMA Producer. The Production Tolerances listed in **Table 5 - Production Tolerances** will be applied to the target values of the selected design aggregate structure.

Note: ***Before a design aggregate structure is selected it is recommended that at least two aggregate trial blends be developed that meet all of the volumetric and mechanical requirements. This will provide the SHMA Producer an opportunity to select the best design aggregate structure.***

Table 5 - Production Tolerances

Sieve Size, mm	37.5	25.0	19.0	12.5	9.5	4.75	2.36	1.18	0.600	0.300	0.150	0.075
Tol.	±5	±5	±5	±5	±5	±4	±4	±4	±3	±3	±3	±2

The production tolerance range will be permitted to exceed the control points and enter the restricted zone.

D. Selection of the Design PGB Content for the Selected Aggregate Structure

In this phase of mixture design the SHMA Producer will be required to submit the test results and data analysis from SUPERPAVE gyratory compacted specimens compacted using the selected design aggregate structure at four different PGB contents. The results of this testing will be evaluated to determine the mixture design PGB content. The design PGB content will be selected at the binder content which results in a compacted density of 96% G_{mm} at the design number of gyrations (N_{design}). All other specified volumetric and mechanical properties shall be checked at this binder content to assure that the specified properties are met.

1. Estimation of Trial Binder Contents

A total of four PGB contents will be evaluated in accordance with Section 10 of AASHTO PP28, "Designing SUPERPAVE HMA". These include -0.5 percent below the estimated design PGB content, the estimated design PGB content, +0.5 and +1.0 percent above the estimated design PGB content. If the PGB content used during the selection of the design aggregate structure is within ± 0.2% to one of the four binder contents determined above, it may be used and the other three trial binder contents adjusted accordingly. (i.e., Trial Blend PGB = 5.4%, Estimated Design PGB Content = 5.2%, Design Trial Point PGB Contents = 4.9%, 5.4%, 5.9%, and 6.4%)

2. Data Analysis and Curve Preparation

The SUPERPAVE specimen volumetric and mechanical data will be calculated and analyzed in accordance with Section 10 of AASHTO PP28, "Designing SUPERPAVE HMA".

The SHMA Producer shall prepare for inclusion in the SHMA mixture design submission a separate graphical plot for the following values on a BR-15M "SUPERPAVE Volumetric Property Curves":

- G_{mm} @ N_{design} and $N_{maximum}$ vs Performance Graded Binder Content
- Voids in Mineral Aggregate (VMA) vs Performance Graded Binder Content
- Percent VMA filled with Binder (VFB) vs Performance Graded Binder Content

The plotted values in each graphical plot shall be fitted with a ***smooth curve*** that obtains the "best fit" for all values. The plotted values shall be the average of those test values obtained at each PGB content.

3. Selection of the Design Performance Graded Binder Content

The design PGB content is established at 96% G_{mm} (4% Air Voids) at the design number of gyrations (N_{design}). All other volumetric and mechanical properties (see **Table 6 - SUPERPAVE Design Criteria** and **Table 6.1 - SUPERPAVE Volumetric Design Criteria**) shall be checked at this binder content to assure that the specified volumetric and mechanical criteria are met. If any of the specified volumetric or mechanical properties are not met at the PGB content resulting in 96% G_{mm} a new design aggregate structure will be required.

Table 6 - SUPERPAVE Design Criteria

Property	Criteria
% Density at $N_{initial}$	$<89.0\%$ of G_{mm}
% Density at N_{design}	$=96.0\%$ of G_{mm}
% Density at $N_{maximum}$	$<98.0\%$ of G_{mm}
Voids in the Mineral Aggregate, VMA	See Table 6.1
Voids Filled with Binder, VFB	See Table 6.1
Dust to Effective Binder Ratio, $P_{0.075\ mm}/P_{be}$	See Table 6.1

Table 6.1 - SUPERPAVE Volumetric Design Criteria

<table>
<tr><th rowspan="1">Estimated Traffic, Million 80 kN ESALs</th><th colspan="5">Voids in the Mineral Aggregate</th><th colspan="2">Voids Filled with Asphalt</th><th colspan="2">Dust to Effective Asphalt Ratio</th></tr>
<tr><td rowspan="2"></td><td>9.5mm</td><td>12.5mm</td><td>19.0mm</td><td>25.0mm</td><td>37.5mm</td><td rowspan="2">Min</td><td rowspan="2">Max</td><td rowspan="2">Min</td><td rowspan="2">Max</td></tr>
<tr><td colspan="5">Min</td></tr>
<tr><td><0.3</td><td rowspan="7">15.0 %</td><td rowspan="7">14.0 %</td><td rowspan="7">13.0%</td><td rowspan="7">12.0 %</td><td rowspan="7">11.0 %</td><td>70</td><td>80</td><td rowspan="7">0.6</td><td rowspan="7">1.2</td></tr>
<tr><td><1.0</td><td>65</td><td>78</td></tr>
<tr><td><3.0</td><td>65</td><td>78</td></tr>
<tr><td><10.0</td><td>65</td><td>75</td></tr>
<tr><td><30.0</td><td>65</td><td>75</td></tr>
<tr><td><100.0</td><td>65</td><td>75</td></tr>
<tr><td>>100.0</td><td>65</td><td>75</td></tr>
</table>

E. Moisture Susceptibility Testing

The resultant SUPERPAVE mixture will be evaluated to determine its moisture susceptibility in accordance with T283, "Resistance of compacted Bituminous Mixture to Moisture Induced Damage". If the specified criteria is not met an appropriate amount of anti-stripping agent will be added to the PGB and the mixture retested until passing results are obtained.

Note: This phase of the mixture design process is not required at this time.

VI. SUPERPAVE HOT MIX ASPHALT SPECIMEN FORMULATION

This section outlines specific procedures to be followed by the SHMA Producer when developing the design aggregate structure for a SHMA mixture design and the Regional Laboratory when verifying a mixture design for SHMA volumetric properties. This section outlines the complete procedure for the testing and analysis to establish SHMA volumetric properties and eliminates as many variables as possible to result in precise and uniform testing.

A. Analysis of Plant Aggregate Gradation

The analysis of aggregate gradations and the combining of aggregates to obtain the desired gradation are important steps in the SHMA design. The SHMA Producer shall analyze and

select an aggregate gradation that conforms to the Control Points and Restricted Zones specified in the Contract Documents and yields a mixture that meets the specified volumetric criteria.

This section outlines the method of analyzing aggregates for the SHMA mixture design. There are two types of plants which require different analysis methods. They are batch plants which incorporate their own aggregate screening system, and drum mix plants, whose control of aggregate gradation is based on the gradation of stockpiles. The NYSDOT requirements for SHMA design aggregate analysis for each type of plant systems will be outlined separately.

1. Batch Plants

Obtain an aggregate history of the materials that have been used at a particular batch plant. This history should consist of a minimum of ten (10) samples. The aggregate history should be based on washed gradations performed in accordance with AASHTO T11 and T27. From the aggregate history, a tabulation of the percentages passing each sieve for each of the individual aggregate sizes should be made (i.e., No. 1, No. 1A, screenings or blended fines). When aggregate blends occur, the approximate cold feed blend percentages should be documented. From these tabulations determine the average gradation of each aggregate size that the plant produces. Attention must be given to insure that the gradation history and aggregate samples are representative of normal production.

Note: Plants equipped to re-add all fines from the dust collection system or varying amounts of dust collector fines should be carefully analyzed when evaluating the aggregate history. This aspect should be held constant for the gradation history averaged and when obtaining aggregate samples for the preparation of SHMA specimens.

Once the average gradation is determined for each aggregate size from the aggregate gradation history, a combined blend target gradation is prepared by applying the blend proportion to the average gradation history percentage passing each sieve for each aggregate component. The actual blend target gradation is the total of this calculation for each sieve size for each aggregate component in the mixture.

The averaged individual percent retained for each aggregate size shall be calculated for the size fractions shown in Section VI-B "Aggregate Preparation" in order to determine the batching weights for the SUPERPAVE gyratory compacted specimens and mixture maximum specific gravity samples. These details are explained in Section VI-C "SUPERPAVE Specimen Batching and Compaction".

The aggregate cold feed blend proportions that were used to develop the average gradation history shall also be used during SHMA mixture production. During production, routine adjustments to the aggregate cold feed blend proportions are allowed

to compensate for stockpile variations in aggregate moisture, slight variations in cold bin aggregate gradations, etc.

The batch plant aggregate stockpiles should also be evaluated in accordance with the provisions detailed for drum mix plants. This analysis does not require washed gradations. The results of this analysis shall be used in the determination of the aggregate consensus properties, and may result in a restriction in the blend proportion of one or more aggregate components.

NYSDOT form BR-X4BM "SUPERPAVE Design Aggregate Structure Composite Trial Blend Gradation Summary" shall be used to document this data.

Note: This procedure is illustrated in the sample mix design contained in Appendix 3.

2. Drum Mix Plants

Obtain a gradation history of the material that has been used at a particular drum mix plant. The gradation history should be based on washed gradations performed in accordance with AASHTO T11 and T27. This history should consist of a minimum of the (10) passing samples. From the gradation history, a tabulation of the percentages passing each sieve for each of the individual aggregate sizes should be made (i.e. No. 1, No. 1A, screenings or fines).

Once the average gradation is determined for each aggregate size from the aggregate gradation history, a combined blend target gradation is prepared by applying the blend proportion to the average gradation history percentage passing each sieve for each aggregate component. The actual blend target gradation is the total of this calculation for each sieve size for each aggregate component in the mixture.

The averaged individual percent retained for each aggregate size shall be calculated for the size fractions shown in Section VI-B "Aggregate Preparation" in order to determine the batching weights for the SUPERPAVE gyratory compacted specimens and mixture maximum specific gravity samples. These details are explained in Section VI-C "SUPERPAVE Specimen Batching and Compaction".

NYSDOT form BR-X4DM "SUPERPAVE Design Aggregate Structure Composite Trial Blend Gradation Summary" shall be used to document this data.

Note: This procedure is illustrated in the sample mix design contained in Appendix 3.

B. AGGREGATE PREPARATION

The aggregate samples used in the batching and compaction of SUPERPAVE gyratory compacted specimens and mixture maximum specific gravity samples should be broken down into the size fractions listed in **Table 7 - Aggregate Size Fractions**.

Note: ***At the discretion of the SHMA Producer aggregates may be broken down into individual screen sizes to perform the mixture design. Regardless of if this option is chosen NYSDOT will verify the mixture design using the size fractions listed in Table 7 - Aggregate Size Fractions.***

Table 7 - Aggregate Size Fractions

Size Fraction
+ 37.5 mm
25.0 mm to 37.5 mm
19.0 mm to 25.0 mm
9.5 mm to 19.0 mm
4.75 mm to 9.5 mm
2.36 mm to 4.75 mm
- 2.36 mm

Note: ***NYSDOT recommends batch plant aggregate samples be obtained from individual hot bins. However, this practice is not required.***

The SHMA Producer shall obtain representative aggregate samples in accordance with instructions outlined in Materials Method 5.0(M). Sufficient sample quantities shall be obtained for the SHMA Producer to prepare a minimum of 14 SUPERPAVE gyratory compacted specimens and 14 maximum specific gravity samples, and a sufficient quantity for NYSDOT to prepare a minimum of 4 SUPERPAVE gyratory compacted specimens and 4 maximum specific gravity samples. A total combined aggregate weight of 130 kg should be sufficient for these purposes. Since additional testing is often required, it is recommended that additional aggregate components be obtained when sampling.

C. SUPERPAVE SPECIMENS BATCHING AND COMPACTION

A minimum of two SUPERPAVE gyratory compacted specimens and two mixture maximum specific gravity samples shall be prepared by the SHMA Producer for each of the design aggregate trial blends or each PGB content used to determine the design PGB content. The SUPERPAVE gyratory compacted specimens and the mixture maximum specific gravity

samples shall be prepared in accordance with AASHTO Provisional Standards TP4-93, "Standard Method for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the SHRP Gyratory Compactor" and PP2-94 "Standard Practice for Short and Long Term Aging of Hot Mix Asphalt (HMA)". Short term aging shall be performed in a flat shallow pan that results in a specimen loading rate of 21 to 22 kg/m^2 for four hours at 135°C.

Note: ***NYSDOT will allow a specimen loading rate of 50 kg/m^2 and a 2 hour short term aging time, particularly when dealing with low absorptive aggregates (<2.5% water). However, the Department will be performing mix verification testing using AASHTO PP2-94. Thus, using the alternate procedure will be at the SHMA Producers risk.***

Note: ***NYSDOT recommends making three gyratory specimens as a precaution against potential error.***

Note: ***During the selection of the design PGB content for the selected aggregate structure the SHMA Producer may determine the mixture maximum specific gravity for each PGB content evaluated using the aggregate's effective specific gravity determined during the selection of the design aggregate structure phase of the mixture design. The mixture maximum specific gravity is calculated using the aggregate's effective specific gravity as follows:***

$$G_{mm} = \frac{100}{\frac{P_s}{G_{se}} + \frac{P_b}{G_b}}$$

where:

G_{mm} = ***mixture's maximum specific gravity***

P_s = ***aggregate content, percent by total weight of mixture***

P_b = ***PGB content, percent by total weight of mixture***

G_{se} = ***effective specific gravity of aggregate***

G_b = ***PGB specific gravity***

Note: ***NYSDOT recommends the following gyratory compactor mold loading procedure:***

After short term aging place the SHMA sample onto a sheet of medium weight (23.6 kg) brown craft paper (about 915 mm x 915 mm) and roll opposite ends of the paper to form a tube and fold over the ends to contain the sample. Place the specimen onto an appropriate size pan and pierce both ends of the closed paper roll with a thermometer to measure the mix temperature.

Obtain a gyratory specimen mold and base/top plate, heated to compaction temperature, and place a paper disk in the bottom of the mold. Dump the SHMA sample into the mold from the paper roll in a single drop by holding one end over the mold and releasing the other end of the paper roll. Level the top of the mix sample and place a paper disk and mold top plate (if required) onto the top of the mold and place into the gyratory compactor and compact to the specified maximum number of gyrations. Repeat this process for the remaining SHMA samples(s).

Note: The above mold loading procedure will be used by NYSDOT when monitoring plant produced SHMA for quality assurance, thus it is recommended that all SHMA Producers follow this procedure as a precaution against a potential error when comparing quality assurance test results.

The mixing and compaction temperatures will be determined based on the range of temperatures which result in kinematic viscosities of 0.17 ± 0.02 Pa·s for mixing and 0.28 ± 0.03 Pa·s for compaction when measured in accordance with ASTM D4402. This information should be available from the refinery or terminal distributing the PGB and shall be reported on BR-X6M "Performance Graded Binder Temperature Viscosity Data".

Note: The manufacturer of modified PGBs may recommend mixing and compaction temperatures that are different than those determined based on the kinematic viscosities listed above. The manufacturer recommended mixing and compaction temperatures shall be reported on BR-X6M.

If the mixing bowl or the short term aging pan are being used for the first time, the inside should be lightly coated, using a similar SHMA mixture, prior to batching or aging the first specimen. The mixing bowls, compaction molds and short term aging pans should be clean at the beginning of each SHMA mixture design.

The SUPERPAVE gyratory compaction specimens and mixture maximum specific gravity samples shall be reconstituted per aggregate component and size fraction. Doubled batching of specimens will be allowed at the discretion of the SHMA Producer.

Note: While SUPERPAVE gyratory compaction specimens and mixture maximum specific gravity samples may be doubled batched NYSDOT recommends that the specimens be mixed individually to reduce potential error.

Note: The addition of 0.075 mm material by the SHMA Producer to account for plant fluctuations will be allowed. However, the target value for the 0.075 mm material shown on the JMF should be the actual amount of 0.075 mm material batched less any additional 0.075 mm material added. The control points for 0.075 mm material should still be met after any additional 0.075 mm material is added..

The required SUPERPAVE gyratory compacted specimen size is 115 mm ± 5 mm in height by 150.0 mm in diameter. The mixture maximum specific gravity sample size varies

depending on the nominal maximum aggregate size of the mixture being tested. The actual sample size required is detailed in AASHTO T209. A sample size of 3000 g shall be used for 37.5 mm nominal maximum size mixtures.

Note: The SUPERPAVE gyratory compaction specimen size will vary depending on the specific gravity of the selected aggregate.

The SUPERPAVE gyratory compactive effort is dependant upon the estimated traffic loading in millions of 80 kN equivalent single axel loads. This information is provided by NYSDOT in the Contract Documents. The compactive effort for each of the traffic level considered in SUPERPAVE are detailed in **Table 8 - Design Number of Gyrations** below.

Table 8 - Design Number of Gyrations

Estimated Traffic, Million 80 kN ESALS	<0.3	<1.0	<3.0	<10.0	<30.0	<100.0	>100.0
$N_{initial}$	7	7	7	8	8	9	9
N_{design}	68	76	86	96	109	126	142
$N_{maximum}$	104	117	134	152	174	204	233

The specific composition (i.e., the component size fraction batch weights) of the individual gyratory compacted specimens will be determined following the procedure detailed below.

- Estimate the total gyratory compacted specimen weight required to produce a specimen of the dimensions detailed above. The mixture maximum specific gravity sample size is predetermined based on the nominal maximum aggregate size of the mixture being designed.

- Estimate the initial trial PGB contents for each of the design aggregate trail blends (see Section V-C2 “Estimated Trial Binder Content”) or use the four PGB contents to be evaluated during the selection of the design PGB content phase of the mixture design (see Section V-D1 “Estimation of Trial Binder Contents”).

- Determine the weight of the specimen's PGB content by multiplying the predetermined PGB content percentage by the total weight of the specimen from above (i.e., at 5.5% PGB, then 0.055 x 5000.0 = 275.0 grams of PGB).

  Note: During the selection of the design PGB content for the selected aggregate structure phase of the mixture design it is recommended that a constant aggregate batch weight be used for each of the four design points and that the PGB batch weight be adjusted to simplify the batching procedure. If this procedure is used the mean of the four selected PGB contents should be used to determine the aggregate batch weight determined in below.

The required PGB batch weights can be determined from the following equation:

$$PGBW = \frac{TABW}{1 - PGB_{estimated}} - TABW$$

where:

PGBW	=	***Total Performance Graded Binder Batch Weight (g)***
TABW	=	***Total Aggregate Batch Weight, (g)***
$PGB_{estimated}$	=	***Estimated Performance Graded Binder content (-0.5 % below the estimated design PGB content, the estimated design PGB content, +0.5 and +1.0 % above the estimated design PGB content, i.e., 5.5% = 0.055)***

- Determine total weight of aggregate as follows:

$$TWA = TSW - PGBW$$

where:

TWA	=	Total Weight of Aggregate Batched, (g)
TSW	=	Total Specimen Weight, (g)
PGBW	=	Total Performance Graded Binder Batch Weight, (g)

- Determine the total weight (grams batched) of each individual aggregate component in the specimen by multiplying its pre-determined blend proportion by the total weight of the aggregate in the specimen.

- For each aggregate component determine the batch weights for each aggregate size fraction by multiplying the average percent retained in each size fraction by the total weight (grams batched) for that aggregate component in the specimen. Any cumulative differences found from the actual total weight retained and the grams batched should be compensated for in the size fraction having the most material.

- Using a scale meeting the requirements listed in **Table 9 - Scale Requirements**, zero the tare weight and begin weighing each aggregate component size fraction batch weight into a suitable container. This weighing may be done separately for each aggregate component or cumulatively, at the SHMA Producer's option. Weighing shall be done

starting with the highest percentage material and working toward the lowest percentage material.

Table 9 - Scale Requirements

Test Weight (grams)	Accuracy Requirements
0 - 200	± 0.1 gram
201 - 2000	± 0.05 % of test load
2001 and greater	± 1.0 gram

- If the aggregate components were weighed individually combine all aggregate components to determine the total aggregate specimen weight.
- The total weight of aggregate must equal the predetermined total grams batched weight for the specimen within ± 10.0 grams. If the total is outside these limits, the specimen shall be discarded.

VII. VERIFICATION OF SUPERPAVE HOT MIX ASPHALT MIXTURE DESIGNS

The SHMA Producer will submit a complete SHMA mixture design, including the analysis of 3 distinct aggregate blends and the determination of the optimum PGB content through the analysis of 4 design points, to the Department.

In addition to the completed SHMA mixture design the SHMA Producer shall submit a sufficient sample of aggregates and PGB to the Department for laboratory verification purposes. A minimum of 6 one liter containers of PGB from the plant, the terminal, or the refinery are required so that multiple reheatings of the sample can be avoided. The PGB shall be equally divided between separate clean containers which are sealed and suitable for reheating. The containers shall be labeled with the source of the PGB, the type of modification if any, the date of sampling, and the performance grade designation. If the PGB is modified in any way the samples must be accompanied by the appropriate Materials Safety Data Sheet.

Note: When sampling the PGB, use the approved sampling valve and drain off at least 4 liters from the spout before sampling.

The aggregates shall be presieved by aggregate size into the size fractions as outlined in Section VI-B “Aggregate Preparation”. The aggregate shall be supplied in substantial sealed containers

and shall be labeled with the aggregate source number, aggregate size designation, and size fraction.

NYSDOT will review the submitted SHMA design and either assign Verification Status or reject the mixture design within four weeks following submission.

The Regional Materials Engineer will review the submitted SHMA design to determine if:

- A complete design has been conducted in accordance with Materials Method 5.16 and meets all of the specified volumetric criteria and aggregate consensus property requirements.

- No new aggregate sources for the specific production facility are being used.

- The SHMA gradation is representative of actual plant production and the aggregate target values listed on the JMF correspond to the gradation appearing on the BR-X4B "SUPERPAVE Design Aggregate Structure Trial Blend Gradation Summary" for the selected aggregate blend.

- No excessive variation in the compacted specimen's bulk specific gravity or the mixture's maximum specific gravity data exists at the binder contents evaluated.

- No major renovations to the production facility have been completed since the last mixture design was reviewed and assigned Production Status.

- The submitted design has been completed in a professional manner and contains a reasonable PGB content for the materials used and the design level specified.

- The SHMA Producer and the specific mix designer have both submitted previous designs which were assigned and have maintained Production Status.

Based on the preliminary review of the submitted design the Regional Materials Engineer will either:

- Assign Verification Status to the submitted design.

or

- Reject the submitted design for not meeting the specified mixture volumetric criteria or the aggregate consensus property requirements contained in the standard specifications, addenda, or project proposal.

or

- Determine the submitted design does not meet the criteria listed above and conduct (or have conducted on their behalf) a laboratory verification. The Regional Materials Engineer may wave the laboratory verification requirement and assign Verification Status to the design if

circumstances not covered by this method apply. The Regional Materials Engineer is solely responsible for making this determination.

The tolerances listed in **Table 10 - Laboratory Verification Tolerances** will be used in determining laboratory verification of a submitted design.

Table 10 - Laboratory Verification Tolerances

Design Criteria	Laboratory Verification Tolerance
Air Voids, V_a	± 1.0 %
Voids in the Mineral Aggregate, VMA	Specified Minimum Criteria
Voids Filled with Binder, VFB	Specified Criteria
Dust to Effective Binder Ratio, $P_{0.075\ mm}/P_{be}$	Specified Criteria
% Density at $N_{maximum}$	< 98.0 %
% Density at $N_{initial}$	< 89.0 %

Based on the results of the laboratory mixture design verification, the Regional Materials Engineer will either:

- Assign Verification Status to the submitted design.

or

- Reject the design for not complying with the specified volumetric properties. At this point a complete redesign will be required. As a minimum, this will consist of the analysis of 3 distinct aggregate blends and the determination of the design PGB content through the analysis of 4 design points. If the same aggregates sources are used in the resubmitted design, only 1 additional aggregate blend will be required. When a design is resubmitted, the Mixture Design Verification Procedure starts at the beginning of the verification process.

Once the submitted mixture design has been assigned Verification Status by the Regional Materials Engineer the SHMA Producer must plant verify the design as discussed below.

The SHMA Producer must notify the Regional Materials Engineer and the Contractor 24 hours prior to the initial production of any design which has been assigned Verification Status. If this notice is not given and acknowledged by the Regional Materials Engineer production may not proceed.

The SHMA Producer must monitor all volumetric properties and aggregate gradation during production of a Verification Status design to determine conformance to the specified criteria in accordance with the requirements outlined in Section 402 - Quality Control Asphalt

Concrete - General. Quality control samples shall be obtained using procedures outlined in Materials Procedure 94-4, Testing Frequencies using Random Sampling at a Hot Mix Asphalt (HMA) Plant. All SUPERPAVE gyratory compaction specimens shall be compacted to $N_{maximum}$ gyrations.

The SHMA Producer will be authorized to make necessary adjustments during Verification Status production to bring the design into conformance with the specified volumetric and gradation requirements.

Note: If the SHMA mixture design contains aggregates which do not meet the specified aggregate consensus properties and adjustments are made to the percentages of each aggregate's blend proportion as shown on the JMF in a effort to improve the quality of the plant produced mixture, the SHMA Producer must recalculate the individual Estimate Total Aggregate Consensus Property Quality (EAQ) as outlined in Section V. C. 1. Mixture Consensus Properties to insure that the consensus properties are still met.

SHMA produced during the plant verification of a Verification Status design is allowed to be supplied to Department projects. All efforts should be made to limit the use of material produced during Verification Status to non-mainline areas, however, mainline is not specifically excluded. The Regional Materials Engineer shall notify the Project Engineer-In-Charge prior to the supply of material during Verification Status production.

Quantity Adjustment Factors (QAF) will be determined by the Regional Materials Engineer in accordance with §402 using Table 402-3 - Air Voids in Plant Mixtures (Volumetric Design Mixes) for material produced during Verification Status. When material produced during Verification Status is used on Department projects and the calculated QAF is ≥ 0.90 the Adjusted Payment Quantity determined in accordance with §402 will be calculated using a minimum QAF of 1.0. If the calculated QAF is > 1.0 the actual QAF will be used. When the calculated QAF is < 0.90 the SHMA material will be evaluated by the Department to determine if it may remain in-place. The type of material produced (i.e., base, binder, top), the layer in which it was used (i.e., base, truing and leveling, binder, top), and the location of use (i.e., mainline or a non-critical area) will be primary considerations in the determination of whether the Verification Status material produced can be left in-place. If the SHMA material cannot be left in-place it will be removed at no cost to the Department. However, if the Department determines that the SHMA material can be left in-place, the Adjusted Payment Quantity will be calculated using a QAF of 0.85.

At the conclusion of the third Verification Status production day the Regional Materials Engineer will assign the design Production Status, beginning on the next production day of the particular design. If less than 2,700 cumulative metric tons is produced during the initial 3 production days, the Verification Status of the design will be extended through the conclusion of the production day 2,700 cumulative metric tons is produced. Production Status will then be assigned by the Regional Materials Engineer. During Production Status the Regional Materials Engineer will determine the QAF to be applied to material produced and used on Department projects in accordance with the requirements of §402.

At any time before the Regional Materials Engineer assigns Production Status the SHMA Producer may declare the submitted design rejected. At this point no additional changes will be allowed and a complete redesign will be required. As a minimum, this will consist of the analysis of 3 distinct aggregate blends and the determination of the design PGB content through the analysis of 4 design points. If the same aggregates sources are used in the resubmitted design, only 1 additional aggregate blend will be required. When a design is resubmitted, the Mixture Design Verification Procedure starts at the beginning of the verification process.

VIII. MONITORING PLANT MIXTURE VOLUMETRIC PROPERTIES

Once the mixture design has been assigned Production Status the tolerances listed in **Table 11 - Plant Production Tolerances** shall be applied to monitor the mixture.

Table 11 - Plant Production Tolerances

Volumetric Properties	Plant Production Tolerance*
Air Voids, V_a	---
Voids in the Mineral Aggregate, VMA	- 1.0 %
Voids Filled with Binder, VFB	± 5.0 %
Dust to Effective Binder Ratio, $P_{0.075\ mm}/P_{be}$	± 0.1
% Density at $N_{maximum}$	< 98.8 %
% Density at $N_{initial}$	< 89.5 %

**These tolerances are applied to the specified criteria.*

While air voids govern the determination of the QAFs applied, the SHMA Producer shall work (by adjusting the plant operations) to maintain all volumetric properties within the tolerances listed above.

If a Production Status design consistently results in QAF's < 0.94 (this may include Verification Status production) NYSDOT may reject the design. The rejection will become effective after written notification is made and a "grace period" passes. The grace period will consist of a maximum of 10 production days of the rejected mix design (regardless of the amount produced during these ten days). If adjustments are made to the design which improve the quality of the material produced during the grace period, the SHMA Producer may request reinstatement of the design. The Regional Materials Engineer is solely responsible for determining if a design should be reinstated. If a request for reinstatement is not made during the grace period, the rejection is final. At this point no additional changes will be allowed and a complete redesign

will be required. If a design is rejected following the conclusion of paving operations for the construction season, the grace period will begin the first production day of the next year.

If a mixture exhibits poor field performance (i.e., shoving, rutting, flushing, etc.) during the course of a project, NYSDOT will immediately suspend production in accordance Sections 105 - Control of Work and 106 - Control of Material. Material production will not resume until the cause of the problem has been identified and corrected to the satisfaction of the Regional Materials Engineer.

NOTES

APPENDIX

APPENDIX 1

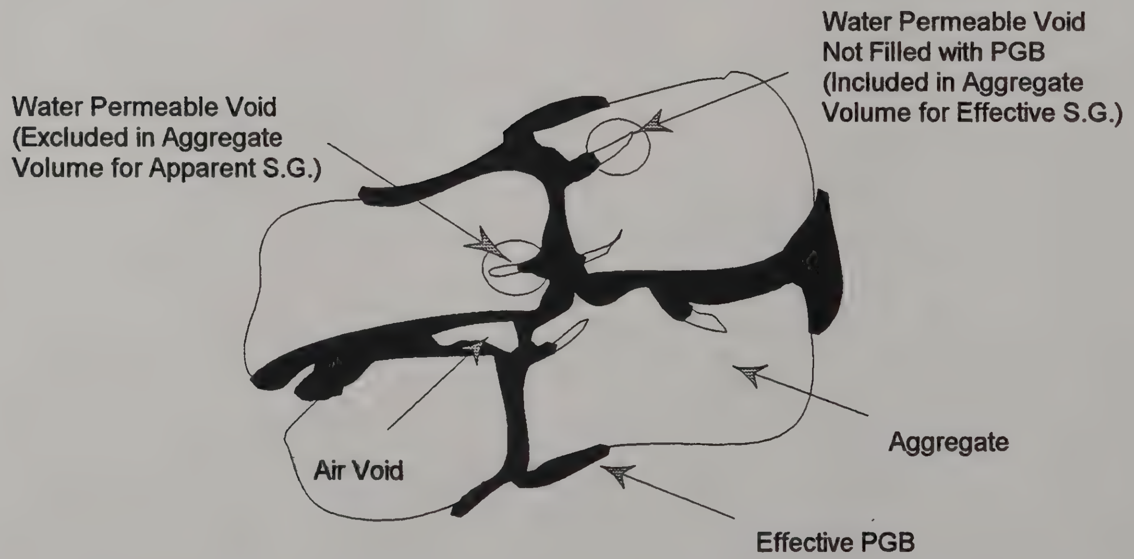
VOLUMETRIC ANALYSIS OF RAW MATERIALS AND SUPERPAVE SPECIMENS

A. DEFINITION OF TERMS

Mineral aggregates are porous and can absorb water and asphalt to a variable degree. Also, the ratio of water to PGB absorption varies with each aggregate. Three methods of measuring aggregate specific gravity take these absorption variations into consideration (see Figure 1). They are bulk, apparent, and effective specific gravities, and these are defined as follows:

> *Bulk Specific Gravity*, G_{sb} - the ratio of the weight in air of a unit volume of permeable material (including both permeable and impermeable voids normal to the material) at a stated temperature to the weight in air of equal density of an equal volume of water at a stated temperature.
>
> *Effective Specific Gravity*, G_{se} - the ratio of the weight in air of a unit volume of a permeable material (excluding voids permeable to asphalt) at a stated temperature to the weight in air of equal density of an equal volume of water at a stated temperature.
>
> *Apparent Specific Gravity*, G_{sa} - the ratio of the weight in air of a unit volume of an impermeable material at a stated temperature to the weight in air of equal density of an equal volume of water at a stated temperature.

Figure 1 - PGB / Aggregate Matrix



Note: ***The volume of PGB absorbed by an aggregate is invariably less than the volume of water absorbed. Consequently, the value for the effective***

specific gravity of an aggregate should be between its bulk and apparent specific gravities. When the effective specific gravity falls outside these limits, its value shall be assumed to be incorrect. The calculations, the maximum specific gravity of the total mixture (AASHTO T209), and the composition of the mixture in terms of aggregate and total PGB content should be rechecked for the source of error.

The terms Air Voids (V_a), Effective Binder Content (P_{be}), Voids in the Mineral Aggregate (VMA), Voids in the Mineral Aggregate Filled with Binder (VFB) are used throughout this Materials Method, and are defined as follows:

Air Voids, V_a - the total volume of the small pockets of air between the coated aggregate particles throughout a compacted paving mixture, expressed as a percent of the bulk volume of the compacted paving mixture.

Effective Binder Content, P_{be} - the total PGB content of a paving mixture minus the portion of PGB that is lost by absorption into the aggregate particles.

Voids in the Mineral Aggregate, VMA - the volume of intergranular void space between the aggregate particles of a compacted paving mixture that includes the air voids and the effective asphalt content, expressed as a percent of the total volume of the sample.

VMA Filled With Binder, VFB - the ratio of volume of effective binder content, P_{be}, to the volume of voids in the mineral aggregate, VMA, expressed as a percent.

Minus 0.075 to the Effective Binder Content Ratio - The ratio of the percentage of mineral aggregate passing the 0.075 sieve to the percentage of the effective binder content, P_{be}.

Mixture Maximum Specific Gravity, G_{mm} - The ratio of a mass of a given volume of material to the mass of an equal volume of water. This represents the density of a sample with zero air voids.

Compacted Specimen Bulk Specific Gravity, G_{mb} - The ratio of a mass of a given volume of a compacted specimen (including impermeable air voids) to the mass of an equal volume of water. This represents the density of a sample at the compacted air void content.

B. Analysis Procedures

The following analysis should be documented on Department Form BR-X8M.

1. Individual Material Constituent Specific Gravity Determination

The test procedure for aggregate specific gravity determination shall be performed according to AASHTO T85 "Specific Gravity and Absorption of Fine Aggregates" and T84 "Specific Gravity and Absorption of Coarse Aggregates".

The aggregate specific gravities that are used to determine mixture volumetric properties during mixture verification and plant production monitoring will be based on the running average of the last six tests (or less) that were performed on each source. If no previous specific gravity testing has been performed, the previously untested aggregate used in the mixture design shall be tested and the resultant values used.

The apparent specific gravities of the PGB (AASHTO T228) and of the mineral filler (AASHTO T100) may be obtained from the supplier of these materials. The PGB specific gravity is generally given at 16°C. To convert this specific gravity to 25°C a multiplication factor of 0.9941 shall be applied. PGB specific gravity at 25°C is needed for SHMA design.

2. Composite Aggregate Bulk and Apparent Specific Gravity Determination

When the total aggregate consists of separate fractions of coarse and fine aggregate and mineral filler, all having different specific gravities, the bulk and apparent specific gravities for the total aggregate are calculated as follows:

$$G_{sb} = G_{sa} = \left[\frac{P_1 + P_2 + \ldots + P_n}{\frac{P_1}{G_1} + \frac{P_2}{G_2} + \ldots + \frac{P_n}{G_n}}\right]$$

where:

G_{sb} = Bulk specific gravity for the total aggregate,

G_{sa} = Apparent specific gravity for the total aggregate,

P_n = % of individual aggregate components based on total weight of aggregate,

G_n = Bulk or apparent (whichever is applicable) specific gravities of aggregates.

Since the bulk specific gravity of mineral filler is difficult to determine, the apparent specific gravity is used instead. The error is usually negligible due to the small quantity of mineral filler in the hot mixture asphalt mixture.

Calculation using data from the Sample Mixture Design at 5.5% PGB:

$$G_{sb} = \left[\frac{9.45 + 28.35 + 28.35 + 28.35}{\frac{9.45}{2.553} + \frac{28.35}{2.671} + \frac{28.35}{2.671} + \frac{28.35}{2.671}} \right] = 2.659$$

3. Effective Specific Gravity of Aggregate Determination

The effective specific gravity, G_{se}, of the combined aggregates includes all void spaces in the aggregate particles except those that absorb PGB. This is based on the mixture maximum specific gravity, G_{mm} determined in accordance with AASHTO T209. The G_{se} is calculated as follows:

$$G_{se} = \left[\frac{P - P_b}{\frac{P}{G_{mm}} - \frac{P_b}{G_b}} \right]$$

where:

G_{se} = effective specific gravity for the total aggregate,

P = total loose mixture, percent by total weight of mixture = 100 percent,

P_b = performance graded binder, percent by total weight of mixture,

G_{mm} = maximum specific gravity of hot mixture asphalt, AASHTO T209,

G_b = specific gravity of performance graded binder at 25°C.

Calculation using data from the Sample Mixture Design at 5.5% PGB:

$$G_{se} = \left[\frac{100.0 - 5.5}{\frac{100.0}{2.477} - \frac{5.5}{1.032}} \right] = 2.697$$

4. Aggregate Consensus Properties Determination

If any of the aggregate consensus quality requirements specified in the Contract Documents are not met for any of the aggregates used in the proposed mix design, the percentage of use for those aggregate will be limited in the total aggregate blend as determined by the law of partial fractions as detailed below.

$$EAQ = \frac{AQ_1 * PP(R)_1 * PB_1 + AQ_2 * PP(R)_2 * PB_2 + AQ_N * PP(R)_N * PB_N}{PP(R)_1 * PB_1 + PP(R)_2 * PB_2 + PP(R)_N * PB_N}$$

where:

EAQ = Estimated Total Aggregate Consensus Property Quality,

AQ_N = Aggregate Consensus Property Quality (i.e., the percentage of Coarse Aggregate Angularity in a given stockpile),

$PP(R)_N$ = Percentage Passing or Percentage Retained for the specified sieve size for each stockpile,

PB_N = Blend Proportions for each stockpile.

If the estimated aggregate consensus property quality is below that specified in the Contract Documents then the percentage batched for the failing aggregate will be reduced to bring it into conformance.

5. SUPERPAVE Specimen Bulk Specific Gravity Determination

The test procedure for bulk specific gravity shall be performed according to AASHTO T166 “Bulk Specific Gravity of Compacted Bituminous Mixture Using Standard Surface-Dry Specimens”.

The bulk specific gravity test may be performed as soon as the freshly compacted specimens have cooled to room temperature.

A scale with ample capacity, readable and sensitive to 0.1 gram, and accurate to the requirements listed in “Table 1 - Scale Accuracy Requirements” is required. The resultant bulk specific gravity shall be calculated to three decimal places. Specific gravity values that result in a range greater than 0.02 within the same PGB content shall be considered invalid and shall not be included in the data averaging. Additional SUPERPAVE gyratory compacted samples will be required if this situation occurs.

Calculate the bulk specific gravity of the specimen as follows:

$$G_{mb} = \frac{A}{(B - C)}$$

where:

G_{mb} = bulk specific gravity of compacted mixture,

A = weight of the dry specimen in air,

B = weight of the saturated surface dry specimen in air,

C = weight of specimen in water.

Note: ***All weight measurements shall be recorded to the nearest tenth of a gram.***

6. Mixture Maximum Specific Gravity Determination

The test procedure for Mixture Maximum Specific Gravity shall be performed according to AASHTO T209 "Maximum Specific Gravity of Bituminous Mixture".

This test shall be conducted on a minimum of two loose mixture specimens for each design aggregate trial blend or each PGB content used to determine the design PGB content. The sample size varies depending on the nominal maximum aggregate size of the mixture being tested. The actual sample size required is detailed in the test procedure. A sample size of 3000 g should be used for 37.5 mm nominal maximum size mixtures. A minimum 2000 ml pycnometer or flask shall be used (a 2000 g metal pycnometer is recommended). If the capacity of the pycnometer is not large enough to accommodate the required sample size the sample may be split into smaller samples (with a combined mass in excess of the required minimum sample size) and averaged (i.e., an average of four samples).

A scale readable and sensitive to 0.1 gram, and accurate to the requirements listed in "**Table 1 - Scale Accuracy Requirements**" is required.

A constant vacuum shall be maintained in the pycnometer at all times. The vacuum level required is a minimum of 30 mm Hg. This level of vacuum is virtually impossible to maintain by any other means than a precision vacuum pump. It is suggested that the vacuum level be maintained as close as possible to the required minimum of 30 mm Hg. Further, mounting a manometer to each vacuum vessel is also considered to be beneficial.

Note: ***NYSDOT recommends the use of a residual pressure manometer to monitor the vacuum achieved during this test.***

The supplemental procedure detailed in Section 8 of T209 for mixtures containing porous aggregate is required to be run on all SHMA mixtures regardless of aggregate adsorption.

Note: ***In order to reduce the testing time required to perform the supplemental procedure detailed in Section 8 of T209 NYSDOT will allow a centrifuge extraction apparatus meeting the requirements of AASHTO T-164 "Quantitative Extraction of Bitumen from Bituminous Paving Mixtures"***

to be used to remove the majority of the excess water following procedure below:

Drain a portion of the water from the sample, taking care to prevent the loss of fine particles. Place the remaining water and the maximum specific gravity sample into the extraction bowl. Place a filter ring on the bowl and clamp the cover on the bowl tightly and place the extraction bowl into the extraction apparatus. Start the centrifuge revolving slowly and gradually increase the speed to a range of 2500 to 3000 rpm. When the flow of water from the drain becomes a slow drip stop the centrifuge. Carefully transfer the sample to a metal pan of sufficient dimension to allow the sample to be spread in a thin layer, taking care to remove any particles that cling to the filter paper. Place the material before an electric fan to remove the remaining surface moisture. At this point continue with the requirements of Section 8.2 of T209.

Mixture maximum specific gravity results differing by more than 0.011 at the same PGB content shall be considered invalid and run again.

Calculate the specific gravity of the sample as follows:

$$G_{mm} = \frac{A}{A' + D - E}$$

where:

G_{mm} = maximum specific gravity of SHMA,

A = weight of dry sample in air,

A' = weight of surface-dry sample in air,

D = weight of flask filled with airless water at 25°C,

E = weight of flask filled with water and sample at 25°C,

Note: All weight measurements must be recorded to the nearest tenth of a gram.

FIGURE V-D-2 shows a typical BR-76 worksheet.

7. Percentage Density (%G_{mm}) and Air Voids (V_a) Determination

The Air Voids (V_a) in a compacted paving mixture consist of the small air spaces between the coated aggregate particles. Using the SUPERPAVE gyratory compacted specimen average bulk specific gravity and the average mixture maximum specific

gravity for each trial aggregate blend or PGB content used in the design PGB content phase of the mixture design, calculate the percentage density and air void content of the specimens as follows:

$$\% G_{mm} = \frac{G_{mb}}{G_{mm}} x\ 100$$

$$V_a = 100 - \%G_{mm}$$

where:

$\%G_{mm}$ = percentage compaction, % of the compacted specimens bulk density to the mixtures maximum density, reported to the nearest 0.01%,

V_a = air voids in compacted mixture, % of total volume, reported to the nearest 0.01%,

G_{mm} = mixture maximum specific gravity of hot mix asphalt,

G_{mb} = bulk specific gravity of SUPERPAVE gyratory compacted specimens.

8. Percent VMA Determination

The VMA is calculated on the basis of the bulk specific gravity of the aggregate, G_{sb}, and is expressed as a percentage of the bulk specific gravity of the compacted paving mixture, G_{mb}. The VMA is calculated as follows:

$$VMA = 100 - \left[\frac{G_{mb}\ P_s}{G_{sb}}\right]$$

where:

VMA = voids in mineral aggregate (% of bulk volume),

G_{sb} = bulk specific gravity for the total aggregate,

G_{mb} = bulk specific bulk gravity of compacted mixture (AASHTO T166),

P_s = aggregate, percent by total weight of mixture.

Calculation using data from the Sample Mixture Design at 5.5% PGB:

$$VMA = 100 - \left[\frac{2.373 \ x \ 94.5}{2.659}\right] = 15.66$$

9. Percent VMA Filled with Binder (VFB) Determination

The VFB is calculated on the basis of the Voids in the Mineral Aggregate, VMA, and is expresses as a percentage of the VMA that is filled with PGB. VFB is calculated as follows:

$$VFB = 100\left[\frac{VMA - V_a}{VMA}\right]$$

where:

VFB = % VMA filled with effective performance graded binder,

VMA = Voids in Mineral Aggregate,

V_a = Air Voids, percent of total volume.

Calculation using data from the Sample Mixture Design at 5.5% PGB:

$$VFB = 100\left[\frac{15.66 - 4.2}{15.66}\right] = 73.18$$

10. Effective Performance Graded Binder Content Determination

The effective PGB content of a paving mixture is the portion of the total PGB content that remains as a coating on the outside of the aggregate particles, and is the PGB content on which service performance of a hot mixture asphalt paving mixture depends. The effective PGB content is calculated as follows:

$$P_{be} = \frac{G_b\,(VMA - V_a)}{G_{mb}}$$

where:

P_{be} = effective performance graded binder content, percent by total weight of mixture,

G_b = specific gravity of performance graded binder at 25°C,

VMA = Voids in Mineral Aggregate,

V_a = Air Voids, percent of total volume,

G_{mb} = bulk specific gravity of compacted mixture.

Calculation using data from the Sample Mixture Design at 5.5% PGB:

$$P_{be} = \frac{1.032\ (15.66\ -\ 4.2)}{2.373} = 4.98$$

11. Dust (Minus 0.075 mm Aggregate) to Effective PGB Content Ratio

The dust (minus 0.075 mm aggregate) to effective PGB content ratio is calculated as follows:

$$P_{0.075\,mm}\ /\ P_{be} = \frac{\%\ P_{0.075\,mm}}{P_{be}}$$

where:

$P_{0.075mm}/P_{be}$ = Minus 0.075 mm Aggregate to the Effective PGB Content Ratio,

$\%P_{0.075mm}$ = percent of aggregate passing the 0.075 mm sieve, percent by total weight of aggregate,

P_{be} = effective performance graded binder content, percent by total weight of mixture.

Calculation using data from the Sample Mixture Design at 5.7% PGB:

$$F/P_{be} = \frac{2.8}{4.66} = 0.60$$

APPENDIX 2

LABORATORY EQUIPMENT LIST

All manufacturers and models of equipment mentioned subsequently are offered as examples which have been observed to conform consistently to the AASHTO Standards applicable. Each individual piece of equipment used in the preparation of a SHMA mixture design must be calibrated to the applicable AASHTO Standard *before* use. This is a suggest equipment list only.

General

1. Thermometers - of appropriate quality to meet the requirements of the specific tests
2. Sieve shaker
3. Fine aggregate splitter
4. Coarse aggregate splitter
5. Scales - meeting the requirements of AASHTO M231

Mixture Design and Analysis

1. SUPERPAVE gyratory compactor meeting the requirements of Item 18403.9995

   Note: ***SUPERPAVE gyratory compactors shall have the angle, pressure, and height measurement calibration verified on a monthly basis by the SHMA Producer. A log of these verifications shall be maintained with the compactor.***

2. Specimen mold assembly conforming to Item 18403.9995
3. Specimen extractor
4. Ovens - of appropriate quality to meet the requirements of the specific tests
5. Mixer - mechanical mixers are recommended
6. Bowls - stainless steel bowls are recommended
7. Steel spoons
8. Sample trays - suitable to run the short term aging test for both the gyratory specimen and the mixture maximum specific gravity specimen and meet the specified loading requirements

Mixture Maximum Specific Gravity Determination

1. Vacuum pump with gauge conforming to AASHTO T209
2. Pycnometers - for running test in accordance with AASHTO T209, minimum capacity of 2000 ml, metal are recommended
3. Water tank - a watertight tank equipped with an overflow outlet for maintaining a constant water level, a heater and circulator are recommended
4. Residual pressure manometer - recommended but not required

Flat and Elongated Particles Determination

1. Suitable measuring equipment, a proportional caliper device is recommended

Fine Aggregate Angularity Determination

1. Cylindrical measure
2. Funnel
3. Funnel stand
4. Glass plate - for calibration

Sand Equivalent Content Determination

1. Graduated plastic cylinder, rubber stopper, irrigator tube, weighted foot assembly, and siphon assembly meeting the requirements of AASHTO T176
2. 85 ml tinned box
3. Wide mouth funnel - 100 mm in diameter at mouth
4. Shaker - either mechanical or manual

Specific Gravity and Absorption of Coarse Aggregate Determination

1. Wire basket conforming to AASHTO T85
2. Water tank - a watertight tank equipped with an overflow outlet for maintaining a constant water level, a heater and circulator are recommended

Specific Gravity and Absorption of Fine Aggregate Determination

1. Pycnometer conforming to AASHTO T84
2. Metal mold conforming to AASHTO T84
3. Tamper

Resistance of Compacted Bituminous Mixtures to Moisture Induced Damage Determination

(This testing is not required at this time)

1. Water bath - 60°C ± 1°C
2. Breaking head
3. Test press conforming to AASHTO T245
4. Suitable load measuring device conforming to AASHTO T245
5. Freezer

APPENDIX 3

COMPLETED MIXTURE DESIGN - SAMPLE

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

SUPERPAVE JMF Submittal Checklist

MIX TYPE 12.5 mm ITEM 18403.1261M REGION 1

PRODUCER XYZ HMA Corporation LOCATION Youngstown, NY

DESIGN NO. OF ESAL's < 3.0 million

DRUM PLANT		BATCH PLANT	
BR - X1M	✓	BR - X1M	
BR - X2DM	✓	BR - X2BM	
BR - X3M	✓	BR - X2S	
BR - X4DM	✓	BR - X3M	
BR - X5M	✓	BR - X4BM	
BR - X6M	✓	BR - X5M	
BR - X7M	✓	BR - X6M	
BR - X8M	✓	BR - X7M	
BR - X9M	✓	BR - X8M	
BR - 10M	✓	BR - X9M	
BR - 11M	✓	BR - 10M	
BR - 12M	✓	BR - 11M	
BR - 13M	✓	BR - 12M	
BR - 14M	✓	BR - 13M	
BR - 15M	✓	BR - 14M	
		BR - 15M	

BR - X2DM (2/97)
DRUM PLANT

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU
SUPERPAVE AVERAGE WASHED GRADATION SUMMARY

REGION 1
ITEM 18403.1261 M
MIX TYPE 12.5 mm
LOCATION Youngstown, NY
DESIGN NO. OF ESAL's < 3.0 million

NUMBER OF SAMPLES AVERAGED 10

AGGREGATE INFORMATION

Aggregates		Source Number	CA Angularity	FA Angularity	Flat & Elongated	Sand Equivalent
Coarse	No. 3 Stone					
	No. 2 Stone					
	No. 1 Stone					
	No. 1 Non Carbonate Stone	1-4R	97/93		0.5	
	No. 1A Stone					
	No. 1A Non Carbonate Stone	1-4R	98/94			
Fine	Manufactured	1-4R		48		65
	Natural	1-8F		43		97
MINERAL FILLER						

Remarks :

AVERAGE STOCKPILE BREAKDOWN

SIEVE SIZE	STOCKPILE NO. 1		STOCKPILE NO. 1A		STOCKPILE NO. Sand		STOCKPILE NO. Screenings		STOCKPILE NO.		STOCKPILE NO.		STOCKPILE NO.		STOCKPILE NO.		MINERAL FILLER	
	retained	passing	retained	passing	retained	passing	retained	passing	retained	passing	retained	passing	retained	passing	retained	passing	retained	passing
50.000 mm																		
37.500 mm																		
25.000 mm																		
19.000 mm	0	100																
12.500 mm	4	96																
9.500 mm	39	57	0	100	0	100	0	100										
4.750 mm	55	2	68	32	1	99	1	99										
2.360 mm	1	1	30	2	26	73	23	76										
1.180 mm			1	1	24	49	27	49										
0.600 mm					20	29	16	33										
0.300 mm					16	13	6	27										
0.150 mm					7	6	9	18										
0.075 mm					3	3	4	14										
PAN	1	0	1	0	3	0	14	0										
TOTAL	100	-	100	-	100	-	100	-										

BR - X3M (2/96)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

SUPERPAVE Design Aggregate Structure
Trial Blend Consensus Property Summary

REGION i

ITEM 18403.1261M

MIX TYPE 12.5 mm

LOCATION Youngstown, NY

DESIGN NO. OF ESAL's < 3.0 million

AGGREGATE INFORMATION			Combined Blend #1							Combined Blend #2							Combined Blend #3						
	Aggregates	Source Number	Blend %	High Friction Blend	Man./Nat. Sand Blend	CA Angularity	FA Angularity	Flat & Elongated	Sand Equivalent	Blend %	High Friction Blend	Man./Nat. Sand Blend	CA Angularity	FA Angularity	Flat & Elongated	Sand Equivalent	Blend %	High Friction Blend	Man./Nat. Sand Blend	CA Angularity	FA Angularity	Flat & Elongated	Sand Equivalent
Coarse	No. 3 Stone																						
	No. 2 Stone																						
	No. 1 Stone																						
	No. 1 Non Carbonate Stone	1-4R	30	100		97/93		0.5		28	100		97/93		0.5		25	100		97/93		0.5	
	No. 1A Stone																						
	No. 1A Non Carbonate Stone	1-4R	31	100		98/94				28	100		98/94				25	100		98/94			
Fine	Manufactured	1-4R	15		38/62		48		65	23		52/48		48		65	25		50/50		48		65
	Natural	1-8F	24				43		97	21				43		97	25				43		97
MINERAL FILLER																							
			Combined Properties			98/94	45			Combined Properties			98/94	46			Combined Properties			98/94	46		

Remarks :

Prepared By : Jordan Bailey

Date : 2-15-97

BR - X4DM (2/96)

DRUM PLANT

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

SUPERPAVE Design Aggregate Structure Composite Trial Blend Gradation Summary

REGION 1

ITEM 18403.1261 M

MIX TYPE 12.5 mm

LOCATION Youngstown, NY

DESIGN NO. OF ESAL's <3.0 million

TRIAL BLEND #1 - COMBINED AVERAGE GRADATION

Aggregate	Stockpile	% BATCH	50.0 mm	37.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm
Coarse															
	1	30				30	28.8	17.1	0.6	0.3					
	1A	31				31	31	31	9.9	0.6	0.3				
Fines	screenings	15				15	15	15	14.9	11.4	7.4	5.0	4.1	2.7	2.1
	sand	24				24	24	24	23.8	17.5	11.8	7.0	3.1	1.4	0.7
Mineral Filler															
TOTAL						100	98.8	87.1	49.2	29.8	19.5	12.0	7.2	4.1	2.8
Specification Limits						100	90-100	<90		28-58					2-10

TRIAL BLEND #2 - COMBINED AVERAGE GRADATION

Aggregate	Stockpile	% BATCH	50.0 mm	37.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm
Coarse															
	1	28				28	26.9	16.0	0.6	0.3					
	1A	28				28	28	28	9.0	0.6	0.3				
Fines	screenings	23				23	23	23	22.8	17.5	11.3	7.6	6.2	4.1	3.2
	sand	21				21	21	21	20.8	15.3	10.3	6.1	2.7	1.3	0.6
Mineral Filler															
TOTAL						100	98.9	88	53.2	33.7	21.9	13.7	8.9	5.4	3.8
Specification Limits						100	90-100	<90		28-58					2-10

TRIAL BLEND #3 - COMBINED AVERAGE GRADATION

Aggregate	Stockpile	% BATCH	50.0 mm	37.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm
Coarse															
	1	25				25	24	14.3	0.5	0.3					
	1A	25				25	25	25	8.0	0.5	0.3				
Fines	screenings	25				25	25	25	24.8	19.0	12.3	8.3	6.8	4.5	3.5
	sand	25				25	25	25	24.8	18.3	12.3	7.3	3.3	1.5	0.8
Mineral Filler															
TOTAL						100	99	89.3	58.1	38.1	24.9	15.6	10.1	6.0	4.3
Specification Limits						100	90-100	<90		28-58					2-10

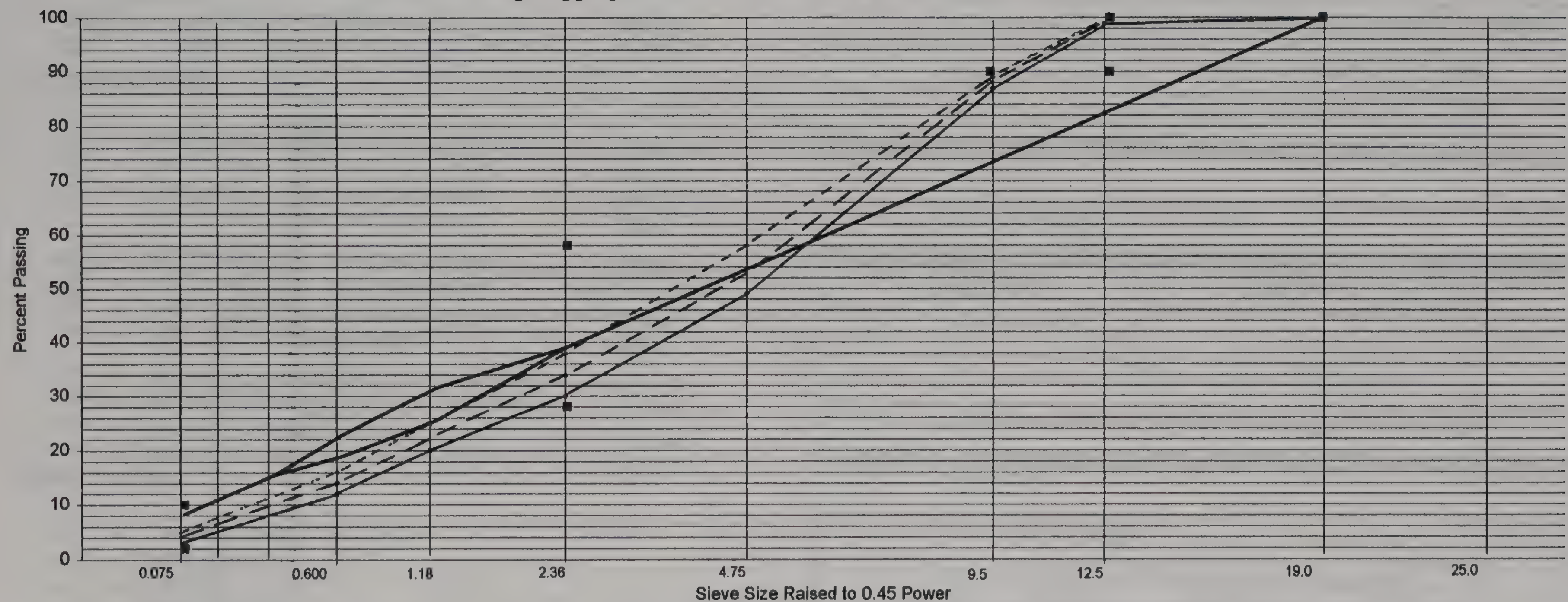
Remarks :

BR - X5M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION 1
ITEM 18403.1261 M
MIX TYPE 12.5 mm
LOCATION Youngstown, NY
DESIGN NO. OF ESAL's <3.0 million

SUPERPAVE Design Aggregate Structure Trial Blend Gradation Plots - 12.5 mm Nom. Size



Sieve Size		0.075 mm	0.150 mm	0.300 mm	0.600 mm	1.18 mm	2.36 mm	4.75 mm	9.5 mm	12.5 mm	19.0 mm	25.0 mm	% Asphalt	Asphalt Grade
% Passing	General Limits	2 - 10					28-58		<90	90-100	100			PG58-34
	Blend #1	2.8	4	7	12	20	30	49	87	99	100		5.7	
	Blend #2	3.8	5	9	14	22	34	53	88	99	100		5.6	
	Blend #3	4.3	6	10	16	25	38	58	89	99	100		5.5	

Prepared By : Jordan Bailey

Date: 2-15-97

Remarks :

BR-X6M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION 1

ITEM 18403.1261 M

MIX TYPE 12.5 mm

LOCATION Youngstown, NY

DESIGN NO. OF ESALs <3.0 million

SUPERPAVE Performance Graded Binder
Temperature Viscosity Data

Variables:

$\mu_{1,2}$ = Viscosity, in centiPoise
G_b = Asphalt Bulk Specific Gravity, AASHTO T 228, G_b = 1.0294
U = $Log_{10}(Log_{10}(\mu))$
t = $Log_{10}(T)$
m = slope of the line
b = Y axis intercept (Log-Log(μ))

Given Variables:

μ_{HM} = Viscosity in centiStokes, High Mixing = 150 cSt
μ_{LM} = Viscosity in centiStokes, Low Mixing = 190 cSt
μ_{HC} = Viscosity in centiStokes, High Compaction = 250 cSt
μ_{LC} = Viscosity in centiStokes, Low Compaction = 310 cSt

U_{HM} = $Log_{10}(Log_{10}(\mu_{HM}))$, High Mixing = 0.3377
U_{LM} = $Log_{10}(Log_{10}(\mu_{LM}))$, Low Mixing = 0.3577
U_{HC} = $Log_{10}(Log_{10}(\mu_{HC}))$, High Compaction = 0.3798
U_{LC} = $Log_{10}(Log_{10}(\mu_{LC}))$, Low Compaction = 0.3964

T_1 = Test Temperature One, in Celsius = 135°C
T_2 = Test Temperature Two, in Celsius = 160°C
T_{K1} = Temperature, in Kelvin, 135° + 273° = 408°K
T_{K2} = Temperature, in Kelvin, 160° + 273° = 433°K

Correction Factors:

$CF_{135°C}$ = Viscosity Reading at 135°C = 0.9325
$CF_{160°C}$ = Viscosity Reading at 160°C = 0.9175

Remarks:

CALCULATIONS

Variable	Calculation	Result
μ_1 cP	Rotational Viscometer Reading at 135°C, in centiPoise	364 cP
μ_1 cSt	μ_1 cP / (0.9325 x G_b), conversion to centiStokes	379 cSt
U_1	$Log_{10}(Log_{10}(\mu_1\ cSt))$	0.4114
t_1	$Log_{10}(T_{K1})$	2.611
μ_2 cP	Rotational Viscometer Reading at 160°C, in centiPoise	100 cP
μ_2 cSt	μ_2 cP / (0.9175 x G_b), conversion to centiStokes	106 cSt
U_2	$Log_{10}(Log_{10}(\mu_2\ cSt))$	0.3065
t_2	$Log_{10}(T_{K2})$	2.637
m	$(U_2 - U_1)/(t_2 - t_1)$	-4.035
b	$U_1 - m \times t_1$	10.9468
T_{HM}	$10^{(0.3377 - b)/m}$ - 273°, High Mixing Temperature, in Celsius	153 °C
T_{LM}	$10^{(0.3577 - b)/m}$ - 273°, Low Mixing Temperature, in Celsius	148 °C
T_{HC}	$10^{(0.3798 - b)/m}$ - 273°, High Compaction Temperature, in Celsius	143 °C
T_{LC}	$10^{(0.3964 - b)/m}$ - 273°, Low Compaction Temperature, in Celsius	139 °C

RECOMMENDED TEMPERATURES WHEN USING MODIFIED BINDERS:

High Mixing Temperature, °C = ______
Low Mixing Temperature, °C = ______
High Compaction Temperature, °C = ______
Low Compaction Temperature, °C = ______

Initial If Using Recommended Temperatures: ______

BR-X7M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

ITEM 18403.1261 M

MIX TYPE 12.5 mm

LOCATION Youngstown, NY

DESIGN NO. OF ESALs < 3.0 million

SUPERPAVE Design Aggregate Structure Mixture Maximum Specific Gravity Summary - AASHTO T209

G_{mm} = Maximum Specific Gravity of Hot Mix Asphalt
A = Weight of dry sample in air (grams)
A' = Weight of final surface-dry sample in air (grams)
D = Weight of pycnometer filled with water at 25°C (grams)
E = Weight of pycnometer filled with sample and water at 25°C(grams)

G_{mm} = A/(A'+D-E)

	Trial Blend #1		Trial Blend #2		Trial Blend #3	
Asphalt Content	5.7 %		5.6 %		5.5 %	
Test No.	1	2	1	2	1	2
A	1584.2	1593.4	1592.6	1582.4	1581.1	1591.5
A'	1588.3	1596.3	1595.3	1587.1	1586.0	1593.8
D	7653.7	7649.8	7653.7	7649.8	7653.7	7649.8
E	8597.8	8599.4	8600.5	8590.5	8600.6	8602.9
G_{mm} = A/(A'+D-E)	2.459	2.464	2.456	2.448	2.474	2.484
Avg. G_{mm}	2.462		2.452		2.479	

Tested by: Jordan Bailey **Date:** 2-15-97

BR - X8M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU
SUPERPAVE Design Aggregate Structure Trial
Blend Compacted Specimen Density Worksheet

REGION 1
ITEM 18403.1261M
MIX TYPE 12.5 mm
LOCATION Youngstown, NY
DESIGN NO. OF ESAL's < 3.0 million

							@ N-maximum				@ N-design			@ N-initial		
	Specimen	Asphalt Content %	Weight - Grams In Air	Weight - Grams In Water	Weight - Grams S.S.D.	Volume CC	Bulk Specific Gravity Gmb	Maximum Specific Gravity Gmm	% Gmm	Specimen Height mm	Specimen Height mm	Bulk Specific Gravity Gmb	% Gmm	Specimen Height mm	Bulk Specific Gravity Gmb	% Gmm
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	p	q
						e - d	c/f		100(g/h)			g X (j/k)	100(l/h)		g X (j/n)	100(p/h)
TRIAL	A	5.7	4788.1	2803.8	4793.0	1989.2	2.407			112.2	114.1	2.367	96.1	128.8	2.097	85.2
BLEND	B	5.7	4798.9	2815.0	4803.1	1988.1	2.414			111.9	113.8	2.374	96.4	128.5	2.102	85.4
#1	AVG.						2.410	2.462	97.9			2.371	96.3		2.100	85.3
TRIAL	A	5.6	4737.3	2791.1	4738.9	1947.8	2.432			112.3	114.2	2.392	97.5	129.0	2.117	86.3
BLEND	B	5.6	4759.3	2803.4	4760.5	1957.1	2.432			113.0	114.9	2.392	97.5	130.0	2.114	86.2
#2	AVG.						2.432	2.452	99.2			2.392	97.5		2.116	86.3
TRIAL	A	5.5	4766.5	2822.4	4767.3	1944.9	2.451			111.7	113.4	2.414	97.4	127.4	2.149	86.7
BLEND	B	5.5	4751.9	2812.0	4752.5	1940.5	2.449			111.5	113.2	2.412	97.3	127.4	2.143	86.5
#3	AVG						2.450	2.479	98.8			2.413	97.3		2.146	86.6

PREPARED BY : Jordan Bailey DATE : 2-15-97

BR - X9M (2/97)

NEW YORK STATE DEPARTMENT OF TRANSPORTATION MATERIALS BUREAU

SUPERPAVE Design Aggregate Structure Trial Blend
Compacted Specimen Volumetric Property Summary

(Analysis by weight of total mixture)
COMPOSITION OF PAVING MIXTURE

REGION i
ITEM 18403.1261M
MIX TYPE 12.5 mm.
LOCATION Youngstown, NY
DESIGN NO. OF ESAL's < 3.0 million

	CONSTITUENT MATERIAL	NYS DOT Source Number	Specific Gravity, G Apparent	Bulk		Reg. Ver.	Mix Composition, % by weight of Total Mix, P — Trial Blend Number 1	2	3
CA	No. 3 Stone								
	No. 2 Stone				P1				
	No. 1 Stone				P2				
	No. 1 Non-Carbonate Stone	1-4R	2.715	2.607	P3		28.29	26.43	23.63
	No. 1A Stone				P4				
	No. 1A Non-Carbonate Stone	1-4R	2.715	2.607	P5		29.23	26.43	23.62
FA	Manufactured	1-4R	2.718	2.675	P6		14.15	21.72	23.63
	Natural	1-8F	2.711	2.597	P7		22.63	19.82	23.62
MINERAL FILLER					P8				
TOTAL AGGREGATE					Ps		94.3	94.4	94.5
ASPHALT CEMENT @ 25C PG				1.022	Pb(ini)		5.7	5.6	5.5

			1	2	3
Gmm	Max. Sp. Gr. of Paving Mix (AASHTO T209)		2.462	2.452	2.479
Gmb	Bulk Sp. Gr. of compacted mix @ Nmax gyrations (AASHTO T166)		2.410	2.432	2.450
%Gmm@Nmax	%Gmm @Nmax = [(Gmb@Nmax)/(Gmm)] x 100		97.9	99.2	98.8
Gmb @Nini	Bulk Sp. Gr. of compacted mix @ Nini gyrations		2.100	2.116	2.146
%Gmm@Nini	%Gmm @ Nini = [(Gmb @Nini)/(Gmm)] x 100		85.3	86.3	86.6
Gmb	Bulk Sp. Gr. of compacted mix @ Ndes gyrations		2.371	2.392	2.413
%Gmm@Ndes	%Gmm @Ndes = [(Gmb@Ndes)/(Gmm)] x 100		96.3	97.5	97.3
Va(@Ndes)	Va(@Ndes) = 100[(Gmm-Gmb@Ndes)/Gmm]		3.7	2.5	2.7
Gsb	Bulk Sp. Gr. of Total aggregate*		2.615	2.620	2.621
Gsa	Apparent Sp. Gr. of Total aggregate		2.714	2.715	2.715
Gse	Effective Sp. Gr. of Total Aggregate Gse = [Ps] / [(100/Gmm) - (Pb/Gb)]		2.691	2.674	2.703
VMA	VMA = 100 - (Gmb@Ndes x Ps/Gsb)		14.5	13.8	13.0
Pb(est)	Pb(est) = Pb(ini) - {0.4 x [4 - Va(@Ndes)]}		5.6	5.0	5.0
VMA(est)	VMA(est) = VMA + {C x [4 - Va(@Ndes)]} w/ C=0.1 if Va(@Ndes)<4 ; >4 then C=0.2		14.5	14.0	13.1
VFB(est)	VFB(est) = 100[(VMA(est) - 4 / VMA(est)]		72.4	71.4	69.5
Pbe	Effective asphalt content Pbe = Pb(est) - {(Ps x Gb) x [(Gse - Gsb)/(Gse x Gsb)]}		4.6	4.3	3.9
F/Pbe (est)	Fines to Eff. AC Ratio = (% passing 0.075 mm sieve)/Pbe		0.61	0.88	1.1

Blend Selected and Why? Blend No. 1 Because it meets all criteria

*EQUATIONS FROM NY MATERIALS METHOD 5.16

Prepared by: Jordan Bailey Date: 2-15-97

BR - 11M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

SUPERPAVE Design PGB Content Compacted

Specimen Density Worksheet

REGION 1

ITEM 18403.1261 M

MIX TYPE 12.5 mm

LOCATION Youngstown, NY

DESIGN NO. OF ESAL's < 3.0 million

						@ N-maximum				@ N-design			@ N-initial		
Specimen	Asphalt Content %	Weight - Grams In Air	Weight - Grams In Water	Weight - Grams S.S.D.	Volume CC	Bulk Specific Gravity Gmb	Maximum Specific Gravity Gmm	% Gmm	Specimen Height mm	Specimen Height mm	Bulk Specific Gravity Gmb	% Gmm	Specimen Height mm	Bulk Specific Gravity Gmb	% Gmm
a	b	c	d	e	f	g	h	i	j	k	l	m	n	p	q
					e - d	c/f		100(g/h)			g X (j/k)	100(l/h)		g X (j/n)	100(p/h)
A	5.2	4674.4	2722.4	4681.2	1953.8	2.392		96.6	113.3	115.2	2.353	95.0	129.7	2.090	84.4
B	5.2	4675.6	2734.3	4680.5	1946.2	2.402		97.0	112.4	114.3	2.362	95.4	128.9	2.095	84.6
AVG.						2.397	2.477	96.8			2.358	95.2		2.093	84.5
A	5.7	4673.9	2735.9	4677.6	1941.7	2.407		97.8	112.2	114.1	2.361	95.9	128.8	2.097	85.2
B	5.7	4669.7	2738.8	4673.0	1934.2	2.414		98.0	111.9	113.8	2.374	96.4	128.5	2.102	85.4
AVG.						2.410	2.462	97.9			2.368	96.2		2.100	85.3
A	6.2	4677.0	2751.4	4681.5	1930.1	2.423		98.9	111.7	113.5	2.385	97.4	128.4	2.108	86.1
B	6.2	4671.2	2751.9	4678.3	1926.4	2.425		99.0	111.3	113.1	2.386	97.4	128.0	2.109	86.1
AVG						2.424	2.449	99.0			2.386	97.4		2.109	86.1
A	6.7	4679.4	2751.7	4682.0	1930.3	2.424		99.6	110.7	112.0	2.396	98.5	126.9	2.115	86.9
B	6.7	4675.7	2751.1	4680.1	1929.0	2.424		99.6	110.9	112.4	2.392	98.3	127.2	2.113	86.8
AVG.						2.424	2.433	99.6			2.394	98.4		2.114	86.9

PREPARED BY : Jordan Bailey DATE : 2-15-97

BR-10M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

ITEM 18403.1261 M

MIX TYPE 12.5 mm

LOCATION Youngstown, NY

DESIGN NO. OF ESALs < 3.0 million

SUPERPAVE Design PGB Content Mixture Maximum Specific Gravity Summary - AASHTO T209

G_{mm} = Maximum Specific Gravity of Hot Mix Asphalt
A = Weight of dry sample in air (grams)
A' = Weight of final surface-dry sample in air (grams)
D = Weight of pycnometer filled with water at 25°C (grams)
E = Weight of pycnometer filled with sample and water at 25°C(grams)

$G_{mm} = A/(A'+D-E)$

Asphalt Content	5.2 %		5.7 %		6.2 %		6.7 %	
Test No.	1	2	1	2	1	2	1	2
A	1583.6	1582.2	1584.6	1593.8	1580.0	1587.3	1584.3	1584.6
A'	1586.1	1586.3	1588.5	1596.4	1583.0	1591.0	1586.9	1588.3
D	7653.7	7649.8	7653.7	7649.8	7653.7	7649.8	7653.7	7649.8
E	8601.3	8596.6	8597.8	8599.4	8591.8	8592.4	8590.0	8586.3
$G_{mm} = A/(A'+D-E)$	2.480	2.474	2.459	2.464	2.450	2.448	2.435	2.431
Avg. G_{mm}	2.477		2.462		2.449		2.433	

Tested by: Jordan Bailey Date: 2-15-97

BR - 12M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

SUPERPAVE Design PGB Content
Compacted Specimen Volumetric Property Summary

(Analysis by weight of total mixture)
COMPOSITION OF PAVING MIXTURE

REGION 1
ITEM 18403.1261 M
MIX TYPE 12.5 mm
LOCATION Youngstown, NY
DESIGN NO. OF ESAL's <3.0 million

	CONSTITUENT MATERIAL		NYS DOT Source Number	Specific Gravity, G: Apparent	Specific Gravity, G: Bulk	Mix Composition, % by weight of Total Mix, P	Reg. Ver.	Mix Sample Number 1	2	3	4
	CA	No. 3 Stone									
		No. 2 Stone				P1					
		No. 1 Stone				P2					
		No. 1 Non-Carbonate Stone	1-4R	2.715	2.607	P3		28.44	28.29	28.14	27.99
		No. 1A Stone				P4					
		No. 1A Non-Carbonate Stone	1-4R	2.715	2.607	P5		29.39	29.23	29.08	28.92
	FA	Manufactured	1-4R	2.718	2.675	P6		14.22	14.15	14.07	14.00
		Natural	1-8F	2.711	2.597	P7		22.75	22.63	22.51	22.39
	MINERAL FILLER					P8					
	TOTAL AGGREGATE					Ps		94.8	94.3	93.8	93.3
	ASPHALT CEMENT @ 25C PG				1.022	Pb		5.2	5.7	6.2	6.7
Gmm	Max. Sp. Gr. of Paving Mix (AASHTO T209)							2.477	2.462	2.449	2.433
Gmb	Bulk Sp. Gr. of compacted mix @ Nmax gyrations (AASHTO T166)							2.397	2.410	2.424	2.424
%Gmm@Nmax	%Gmm @Nmax = [(Gmb@Nmax)/(Gmm)] x 100							96.8	97.9	99.0	99.6
Gmb @Nini	Bulk Sp. Gr. of compacted mix @ Nini gyrations							2.093	2.100	2.109	2.114
%Gmm@Nini	%Gmm @ Nini = [(Gmb @Nini)/(Gmm)] x 100							84.5	85.3	86.1	86.9
Gmb	Bulk Sp. Gr. of compacted mix @ Ndes gyrations							2.358	2.368	2.386	2.394
%Gmm@Ndes	%Gmm @Ndes = [(Gmb@Ndes)/(Gmm)] x 100							95.2	96.2	97.4	98.4
Va(@Ndes)	Va(@Ndes) = 100[(Gmm-Gmb@Ndes)/Gmm]							4.8	3.8	2.6	1.6
Gsb	Bulk Sp. Gr. of Total aggregate*							2.615	2.615	2.615	2.615
Gsa	Apparent Sp. Gr. of Total aggregate							2.714	2.714	2.714	2.714
Gse	Effective Sp. Gr. of Total Aggregate Gse = [Ps] / [(100/Gmm) - (Pb/Gb)]							2.686	2.691	2.698	2.701
VMA	VMA = 100 - (Gmb@Ndes x Ps/Gsb)							14.5	14.6	14.4	14.6
VFB	VFB = [(VMA - Va)/VMA] x 100							66.9	74.0	81.9	89.0
Pbe	Pbe = Pb - [(Ps x Gb) x {(Gse - Gsb)/(Gse x Gsb)}]							4.22	4.66	5.07	5.54
F/Pbe	Fines to Eff. AC Ratio = (% passing 0.075 mm sieve)/Pbe							0.66	0.60	0.55	0.51

Remarks :

*EQUATIONS FROM NY MATERIALS METHOD 5.16

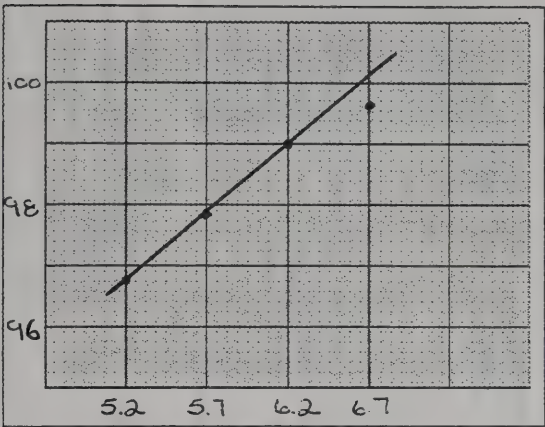
Prepared by: Jordan Bailey Date: 2-15-97

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION	1
ITEM	18403.1261 M
MIX TYPE	12.5 mm
LOCATION	Youngstown, NY
DESIGN NO. OF ESAL's	<3.0 million

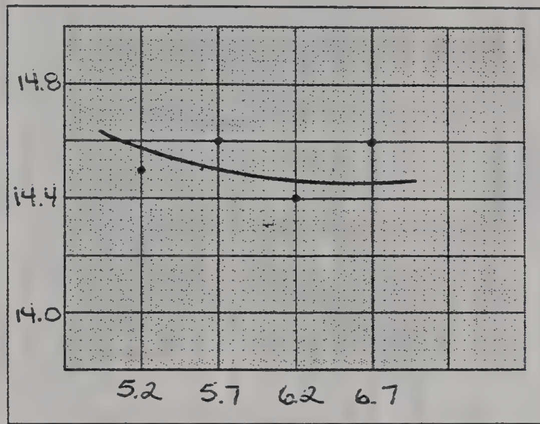
SUPERPAVE VOLUMETRIC PROPERTY CURVES

%Gmm @Nmax



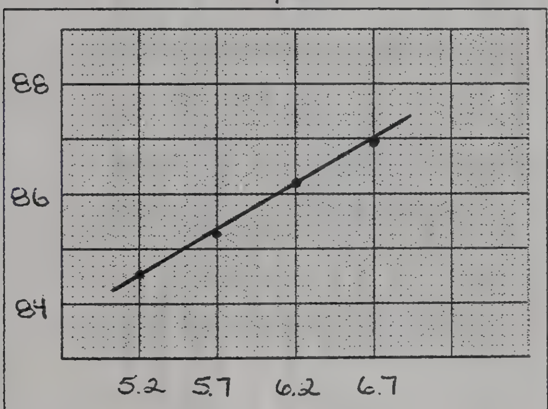
% Asphalt

VMA



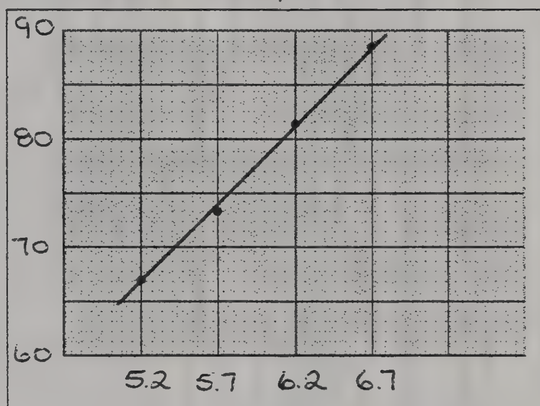
% Asphalt

%Gmm @Nini



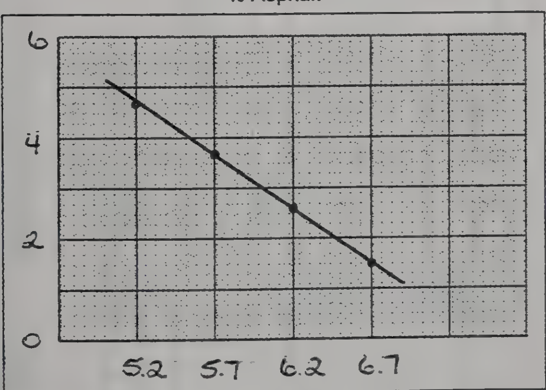
% Asphalt

VFB



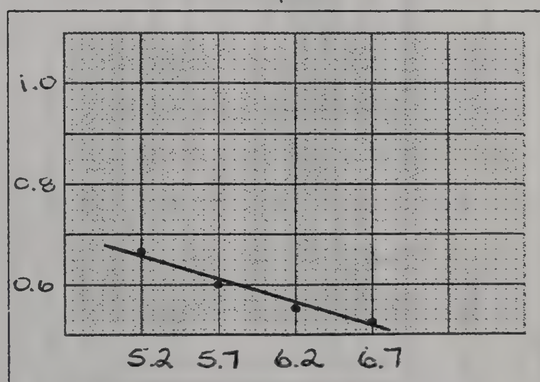
% Asphalt

Va @ Ndes



% Asphalt

D/A



% Asphalt

VALUES AT OPTIMUM AC CONTENT

Property	%Gmm @Nmax	% Gmm @Nini	@ Ndes Va, %	VMA, %	VFB, %	D/A
Specs.	<98%	<89%	4%	14 min.	65-78	0.6-1.2
Actual	97.6	85.1	4.0	14.5	73.0	0.62

Optimum AC Content 5.6 **Submitted By** Jordan Bailey **Date** 2-15-97

BR - 14M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION 1
ITEM 18403.1261M
MIX TYPE 12.5 mm
LOCATION Youngstown, NY
DESIGN NO. OF ESAL's < 3.0 million

SUPERPAVE BATCH WEIGHTS FOR MIXTURE VERIFICATION

COMBINED SUPERPAVE(GYRATORY SAMPLE) GRADATION AT THE % ASPHALT CEMENT INDICATED

% AC	AGGREGATE COMPONENT	% BATCH	GRAMS BATCH	WEIGHT RETAINED (GRAMS) 50.0 mm	37.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	PAN	TOTAL WT. RET.
5.6	1	30	1359.4				0		584.5	747.7	13.6						13.6	1359.4
	1A	31	1404.6				0		0	955.1	421.4						28.1	1404.6
	sand	24	1087.5				0		0	10.9	282.8						793.8	1087.5
	screenings	15	679.7				0		0	6.8	156.3						516.6	679.7
	Mineral Filler	-	-															
	TOTAL	100	4531.2															

(specimen wtg) = 4800 x 5.6 % AC = 268.8 gr. AC

(specimen wtg) = 4800 - 268.8 gr. AC = 4531.2 gr. Aggregate

COMBINED SUPERPAVE(MAXIMUM SPECIFIC GRAVITY SAMPLE) GRADATION AT THE % ASPHALT CEMENT INDICATED

% AC	AGGREGATE COMPONENT	% BATCH	GRAMS BATCH	WEIGHT RETAINED (GRAMS) 50.0 mm	37.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	PAN	TOTAL WT. RET.
5.6	1	30	453.1				0		194.8	249.3	4.5						4.5	453.1
	1A	31	468.2				0		0	318.3	140.5						9.4	468.2
	sand	24	362.5				0		0	3.6	94.3						264.6	362.5
	screenings	15	226.6				0		0	2.3	52.1						172.2	226.6
	Mineral Filler	-	-															
	TOTAL	100	1510.4															

(specimen wtg) = 1600 x 5.6 % AC = 89.6 gr. AC

(specimen wtg) = 1600 - 89.6 gr. AC = 1510.4 gr. Aggregate

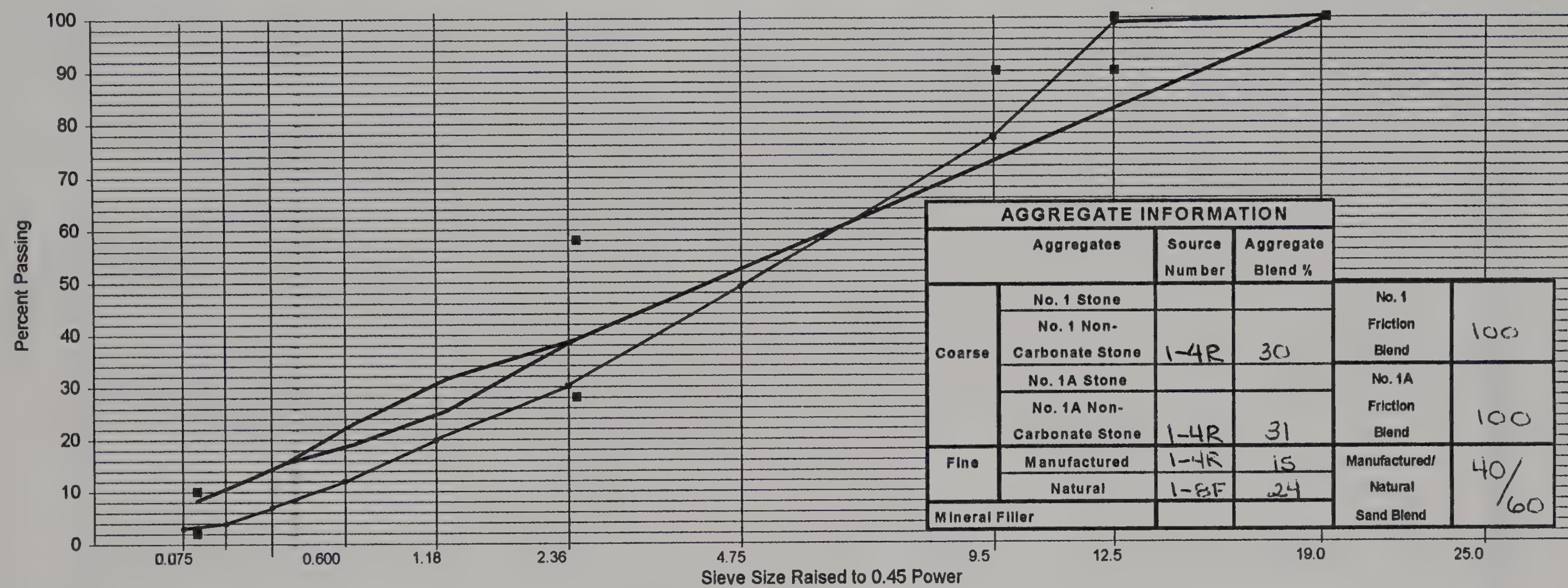
TESTED BY: Jordan Bailey ON: 2-15-97

BR - 15M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

JMF NO.	97011232665834
MIX TYPE	12.5 mm
PRODUCER	XYZHMA Corp.
LOCATION	Youngstown, NY
DESIGN NO. OF ESAL's	< 3.0 million

SUPERPAVE Job Mix Formula - 12.5 mm Nom. Size



AGGREGATE INFORMATION					
	Aggregates	Source Number	Aggregate Blend %		
Coarse	No. 1 Stone			No. 1 Friction Blend	100
	No. 1 Non-Carbonate Stone	1-4R	30		
	No. 1A Stone			No. 1A Friction Blend	100
	No. 1A Non-Carbonate Stone	1-4R	31		
Fine	Manufactured	1-4R	15	Manufactured/ Natural Sand Blend	40/60
	Natural	1-8F	24		
Mineral Filler					

Sieve Size		0.075 mm	0.150 mm	0.300 mm	0.600 mm	1.18 mm	2.36 mm	4.75 mm	9.5 mm	12.5 mm	19.0 mm	25.0 mm	% Asphalt	Asphalt Grade
% Passing	General Limits	2 - 10					28-58		<90	90-100	100			PG58-34
	JMF Range	0.8-4.8	1-7	3-10	9-15	16-24	26-34	45-53	82-92	94-100	95-100		5.6	
	Target Value	2.8	4	7	12	20	30	49	87	99	100		5.6	

Recommended for Review by Regional Director Ryan Anthony

Date: 2-15-97

Revised

Remarks :

APPENDIX 4

BLANK MIXTURE DESIGN FORMS

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

SUPERPAVE JMF Submittal Checklist

MIX TYPE ______ ITEM ______ REGION ______

PRODUCER ______ LOCATION ______

DESIGN NO. OF ESAL's ______

DRUM PLANT		BATCH PLANT	
BR - X1M	______	BR - X1M	______
BR - X2DM	______	BR - X2BM	______
BR - X3M	______	BR - X2S	______
BR - X4DM	______	BR - X3M	______
BR - X5M	______	BR - X4BM	______
BR - X6M	______	BR - X5M	______
BR - X7M	______	BR - X6M	______
BR - X8M	______	BR - X7M	______
BR - X9M	______	BR - X8M	______
BR - 10M	______	BR - X9M	______
BR - 11M	______	BR - 10M	______
BR - 12M	______	BR - 11M	______
BR - 13M	______	BR - 12M	______
BR - 14M	______	BR - 13M	______
BR - 15M	______	BR - 14M	______
		BR - 15M	______

BR - X2DM (2/97)

DRUM PLANT

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU
SUPERPAVE AVERAGE WASHED GRADATION SUMMARY

REGION ______________________

ITEM ______________________

MIX TYPE ______________________

LOCATION ______________________

DESIGN NO. OF ESAL's ______________________

NUMBER OF SAMPLES AVERAGED ________

AGGREGATE INFORMATION

Aggregates		Source Number	CA Angularity	FA Angularity	Flat & Elongated	Sand Equivalent
Coarse	No. 3 Stone					
	No. 2 Stone					
	No. 1 Stone					
	No. 1 Non Carbonate Stone					
	No. 1A Stone					
	No. 1A Non Carbonate Stone					
Fine	Manufactured					
	Natural					
MINERAL FILLER						

Remarks :

AVERAGE STOCKPILE BREAKDOWN

SIEVE SIZE	STOCKPILE NO.		STOCKPILE NO.		STOCKPILE NO.		STOCKPILE NO.		STOCKPILE NO.		STOCKPILE NO.		STOCKPILE NO.		STOCKPILE NO.		MINERAL FILLER	
	retained	passing	retained	passing	retained	passing	retained	passing	retained	passing	retained	passing	retained	passing	retained	passing	retained	passing
50.000 mm																		
37.500 mm																		
25.000 mm																		
19.000 mm																		
12.500 mm																		
9.500 mm																		
4.750 mm																		
2.360 mm																		
1.180 mm																		
0.600 mm																		
0.300 mm																		
0.150 mm																		
0.075 mm																		
PAN																		
TOTAL																		

BR - X2BM (2/97)

BATCH PLANT

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU
SUPERPAVE AVERAGE WASHED GRADATION SUMMARY

REGION ____________

ITEM ____________

MIX TYPE ____________

LOCATION ____________

DESIGN NO. OF ESAL's ____________

NUMBER OF SAMPLES AVERAGED ____________

AGGREGATE INFORMATION		
Aggregates		Source Number
Coarse	No. 3 Stone	
	No. 2 Stone	
	No. 1 Stone	
	No. 1 Non Carbonate Stone	
	No. 1A Stone	
	No. 1A Non Carbonate Stone	
Fine	Manufactured	
	Natural	
Mineral Filler		

AVERAGE BIN BREAKDOWN

SIEVE SIZE	BIN NO.		BIN NO.		BIN NO.		BIN NO.		BIN NO.		MINERAL FILLER	
	retained	passing	retained	passing	retained	passing	retained	passing	retained	passing	retained	passing
50.000 mm												
37.500 mm												
25.000 mm												
19.000 mm												
12.500 mm												
9.500 mm												
4.750 mm												
2.360 mm												
1.180 mm												
0.600 mm												
0.300 mm												
0.150 mm												
0.075 mm												
PAN												
TOTAL												

Remarks :

BR - X2S (2/97)

BATCH PLANT

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU
SUPERPAVE Average Stockpile Gradation Summary
For Aggregate Consensus Property Determination

REGION ______

ITEM ______

MIX TYPE ______

LOCATION ______

DESIGN NO. OF ESAL's ______

NUMBER OF SAMPLES AVERAGED ______

AGGREGATE INFORMATION

Aggregates		Source Number	CA Angularity	FA Angularity	Flat & Elongated	Sand Equivalent
Coarse	No. 3 Stone					
	No. 2 Stone					
	No. 1 Stone					
	No. 1 Non Carbonate Stone					
	No. 1A Stone					
	No. 1A Non Carbonate Stone					
Fine	Manufactured					
	Natural					
MINERAL FILLER						

Remarks :

AVERAGE STOCKPILE BREAKDOWN

SIEVE SIZE	STOCKPILE NO.		STOCKPILE NO.		STOCKPILE NO.		STOCKPILE NO.		STOCKPILE NO.		STOCKPILE NO.		STOCKPILE NO.		STOCKPILE NO.		MINERAL FILLER	
	retained	passing	retained	passing	retained	passing	retained	passing	retained	passing	retained	passing	retained	passing	retained	passing	retained	passing
50.000 mm																		
37.500 mm																		
25.000 mm																		
19.000 mm																		
12.500 mm																		
9.500 mm																		
4.750 mm																		
2.360 mm																		
1.180 mm																		
0.600 mm																		
0.300 mm																		
0.150 mm																		
0.075 mm																		
PAN																		
TOTAL																		

BR - X3M (2/96)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

SUPERPAVE Design Aggregate Structure
Trial Blend Consensus Property Summary

REGION ______________________

ITEM ______________________

MIX TYPE ______________________

LOCATION ______________________

DESIGN NO. OF ESAL's ______________________

AGGREGATE INFORMATION			Combined Blend #1							Combined Blend #2							Combined Blend #3						
	Aggregates	Source Number	Blend %	High Friction Blend	Man./Nat. Sand Blend	CA Angularity	FA Angularity	Flat & Elongated	Sand Equivalent	Blend %	High Friction Blend	Man./Nat. Sand Blend	CA Angularity	FA Angularity	Flat & Elongated	Sand Equivalent	Blend %	High Friction Blend	Man./Nat. Sand Blend	CA Angularity	FA Angularity	Flat & Elongated	Sand Equivalent
Coarse	No. 3 Stone																						
	No. 2 Stone																						
	No. 1 Stone																						
	No. 1 Non Carbonate Stone																						
	No. 1A Stone																						
	No. 1A Non Carbonate Stone																						
Fine	Manufactured																						
	Natural																						
MINERAL FILLER																							
			Combined Properties							Combined Properties							Combined Properties						

Remarks :

Prepared By : ______________________ Date : ______________________

BR - X4DM (2/96)

DRUM PLANT

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

SUPERPAVE Design Aggregate Structure Composite Trial Blend Gradation Summary

REGION ______________________

ITEM ______________________

MIX TYPE ______________________

LOCATION ______________________

DESIGN NO. OF ESAL's ______________________

TRIAL BLEND #1 - COMBINED AVERAGE GRADATION

Aggregate	Stockpile	% BATCH	% Passing Sieve												
			50.0 mm	37.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm
Coarse															
Fines															
Mineral Filler															
TOTAL															
Specification Limits															

TRIAL BLEND #2 - COMBINED AVERAGE GRADATION

Aggregate	Stockpile	% BATCH	% Passing Sieve												
			50.0 mm	37.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm
Coarse															
Fines															
Mineral Filler															
TOTAL															
Specification Limits															

TRIAL BLEND #3 - COMBINED AVERAGE GRADATION

Aggregate	Stockpile	% BATCH	% Passing Sieve												
			50.0 mm	37.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm
Coarse															
Fines															
Mineral Filler															
TOTAL															
Specification Limits															

Remarks :

BR - X4BM (2/97)

BATCH PLANT

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

SUPERPAVE Design Aggregate Structure Composite Trial Blend Gradation Summary

REGION ______________________

ITEM ______________________

MIX TYPE ______________________

LOCATION ______________________

DESIGN NO. OF ESAL's ______________________

TRIAL BLEND #1 - COMBINED AVERAGE GRADATION

Aggregate	BIN	% BATCH	% Passing Sieve												
			50.0 mm	37.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm
Coarse															
Fines															
Mineral Filler															
TOTAL															
Specification Limits															

TRIAL BLEND #2 - COMBINED AVERAGE GRADATION

Aggregate	BIN	% BATCH	% Passing Sieve												
			50.0 mm	37.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm
Coarse															
Fines															
Mineral Filler															
TOTAL															
Specification Limits															

TRIAL BLEND #3 - COMBINED AVERAGE GRADATION

Aggregate	BIN	% BATCH	% Passing Sieve												
			50.0 mm	37.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm
Coarse															
Fines															
Mineral Filler															
TOTAL															
Specification Limits															

Remarks :

TESTED BY : ______________________ **ON** ______________________

BR - X5M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION

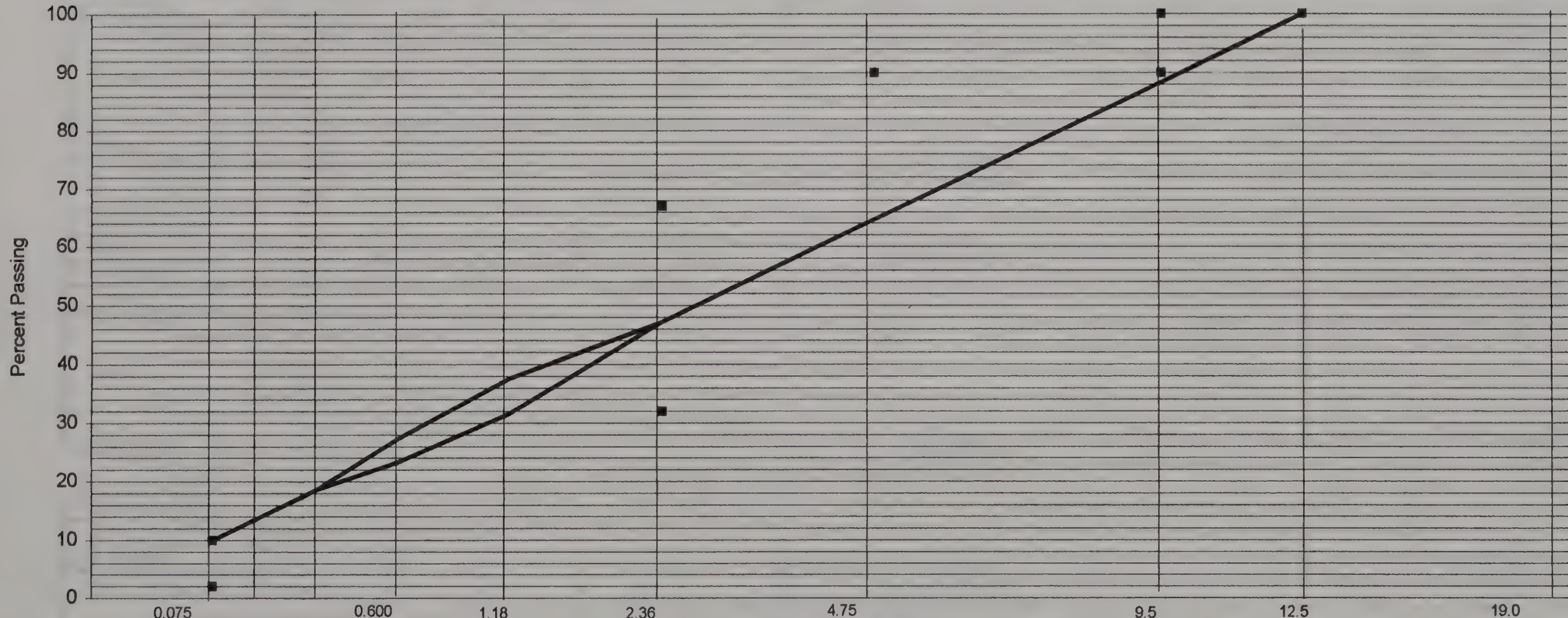
ITEM

MIX TYPE

LOCATION

DESIGN NO. OF ESAL's

SUPERPAVE Design Aggregate Structure Trial Blend Gradation Plots - 9.5 mm Nom. Size



Sieve Size		0.075 mm	0.150 mm	0.300 mm	0.600 mm	1.18 mm	2.36 mm	4.75 mm	9.5 mm	12.5 mm	19.0 mm	% Asphalt	Asphalt Grade
% Passing	General Limits	2 - 10					32-67	<90	90-100	100			PG -
	Blend #1												
	Blend #2												
	Blend #3												

Prepared By :

Date :

Remarks :

BR - X5M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION ____________________

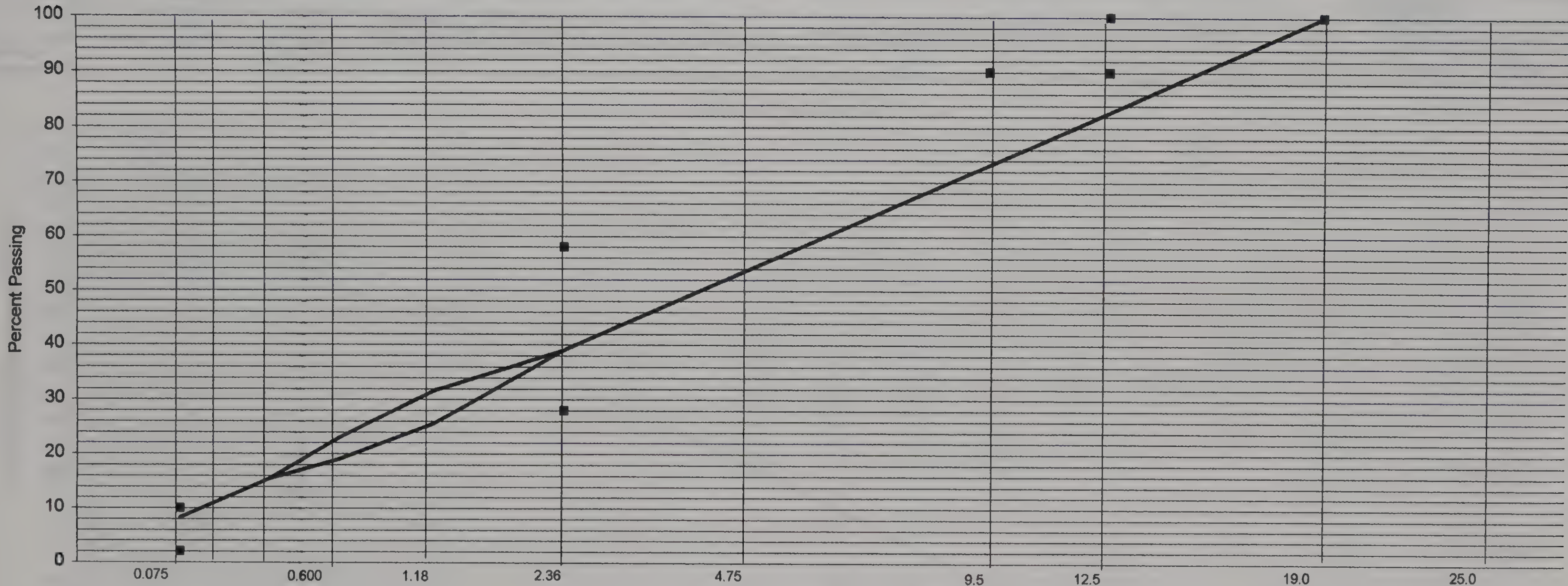
ITEM ____________________

MIX TYPE ____________________

LOCATION ____________________

DESIGN NO. OF ESAL's ____________________

SUPERPAVE Design Aggregate Structure Trial Blend Gradation Plots - 12.5 mm Nom. Size



Sieve Size		0.075 mm	0.150 mm	0.300 mm	0.600 mm	1.18 mm	2.36 mm	4.75 mm	9.5 mm	12.5 mm	19.0 mm	25.0 mm	% Asphalt	Asphalt Grade
% Passing	General Limits	2 - 10					28-58		<90	90-100	100			PG -
	Blend #1													
	Blend #2													
	Blend #3													

Prepared By : ____________________ Date: ____________

Remarks : ____________________

BR - X6M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION ______

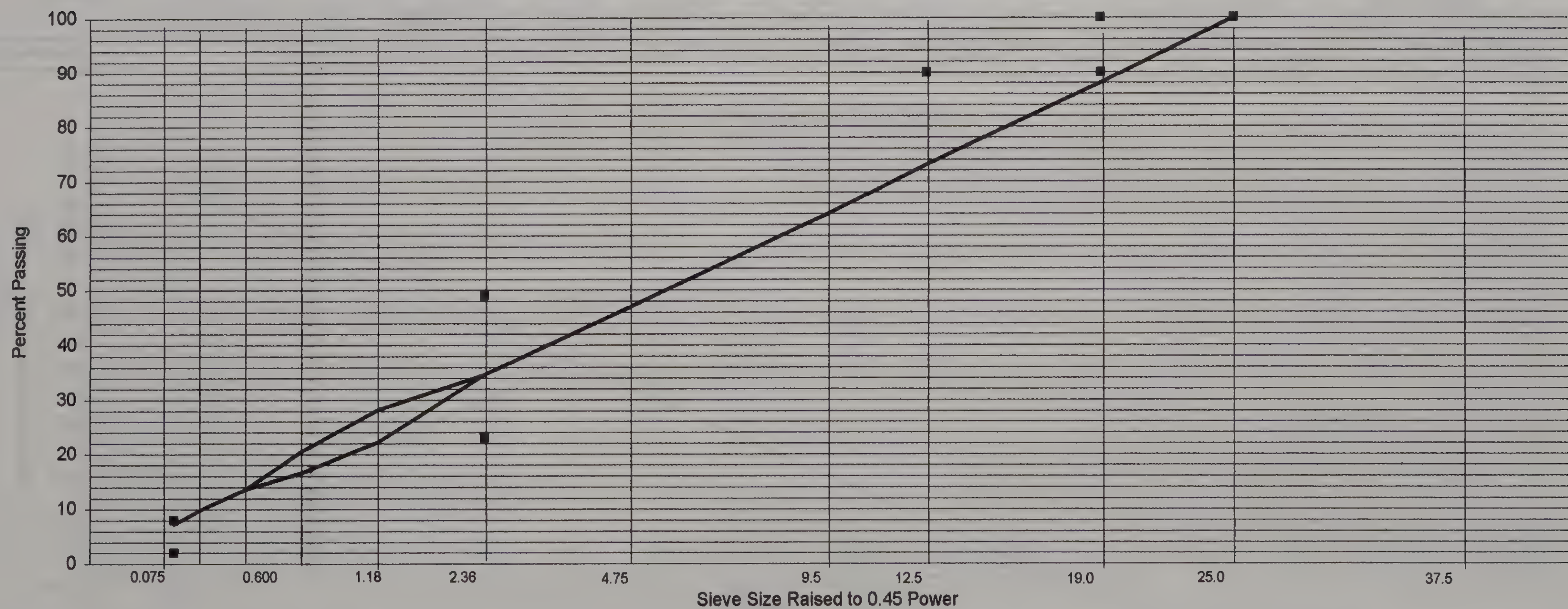
ITEM ______

MIX TYPE ______

LOCATION ______

DESIGN NO. OF ESAL's ______

SUPERPAVE Design Aggregate Structure Trial Blend Gradation Plots - 19.0 mm Nom. Size



Sieve Size		0.075 mm	0.150 mm	0.300 mm	0.600 mm	1.18 mm	2.36 mm	4.75 mm	9.5 mm	12.5 mm	19.0 mm	25.0 mm	37.5 mm	% Asphalt	Asphalt Grade
% Passing	General Limits	2-8					23-49			<90	90-100	100			PG -
	Blend #1														
	Blend #2														
	Blend #3														

Prepared By : ______ Date : ______

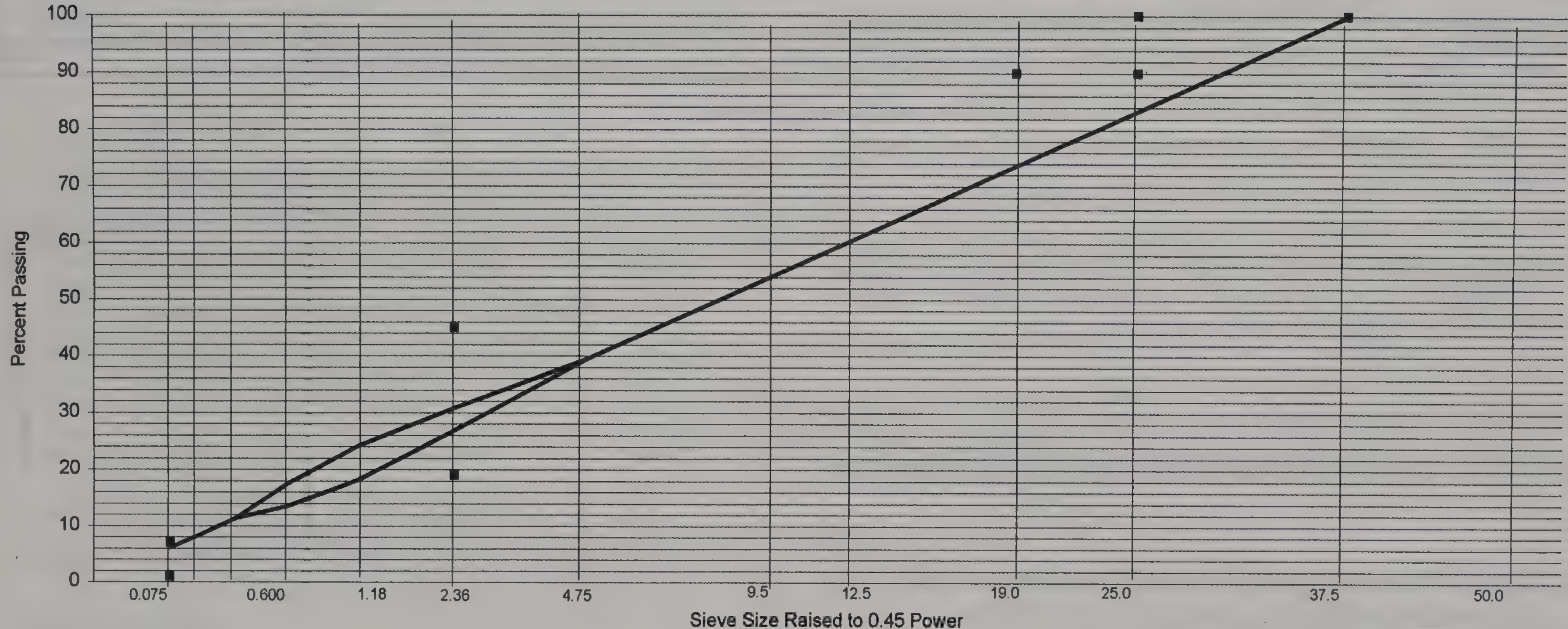
Remarks : ______

BR - X5M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION ______
ITEM ______
MIX TYPE ______
LOCATION ______
DESIGN NO. OF ESAL's ______

SUPERPAVE Design Aggregate Structure Trial Blend Gradation Plots - 25 mm Nom. Size



Sieve Size		0.075 mm	0.150 mm	0.300 mm	0.600 mm	1.18 mm	2.36 mm	4.75 mm	9.5 mm	12.5 mm	19.0 mm	25.0 mm	37.5 mm	50.0 mm	% Asphalt	Asphalt Grade
% Passing	General Limits	1-7					19-45				<90	90-100	100			
	Blend #1															PG -
	Blend #2															
	Blend #3															

Prepared By : ______ Date : ______

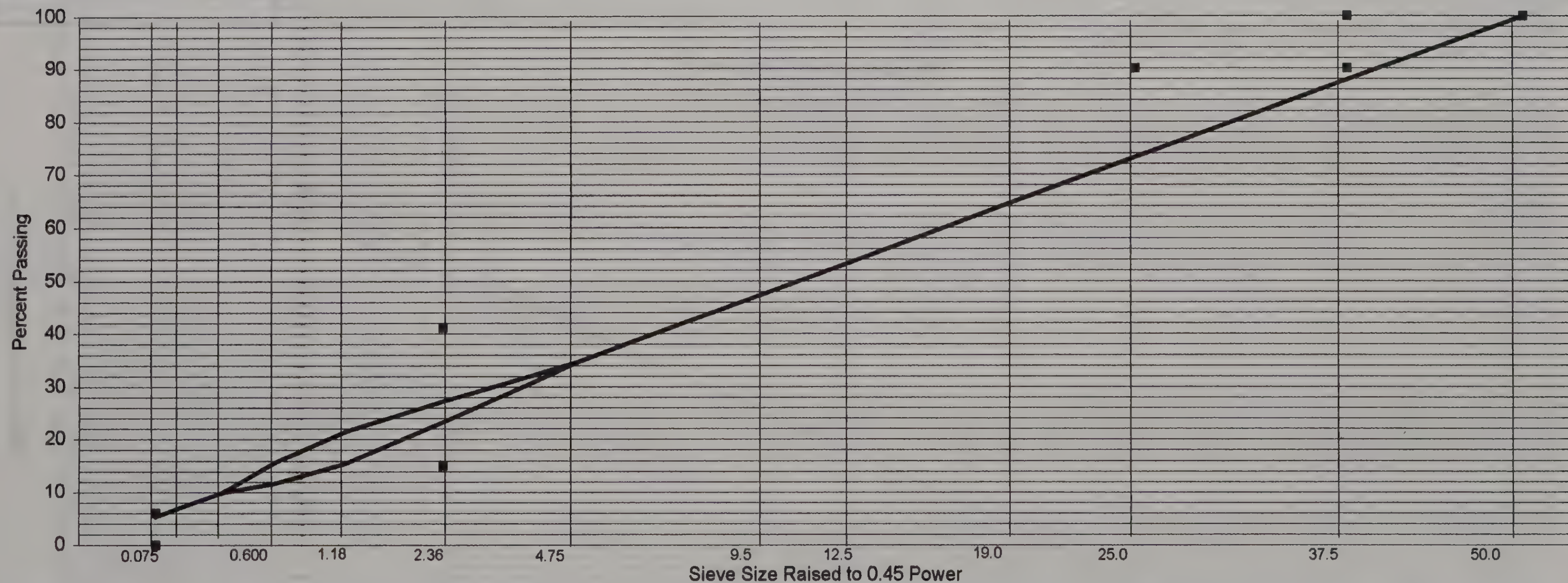
Remarks : ______

BR - X5M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION ______
ITEM ______
MIX TYPE ______
LOCATION ______
DESIGN NO. OF ESAL's ______

SUPERPAVE Design Aggregate Structure Trial Blend Gradation Plots - 37.5 mm Nom. Size



Sieve Size		0.075 mm	0.150 mm	0.300 mm	0.600 mm	1.18 mm	2.36 mm	4.75 mm	9.5 mm	12.5 mm	19.0 mm	25.0 mm	37.5 mm	50.0 mm	% Asphalt	Asphalt Grade
% Passing	General Limits	0-6					15-41					<90	90-100	100		
	Blend #1															PG -
	Blend #2															
	Blend #3															

Prepared By : ______ Date : ______

Remarks : ______

BR-X6M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

ITEM ____________________

MIX TYPE ____________________

LOCATION ____________________

DESIGN NO. OF ESALs ____________________

SUPERPAVE Performance Graded Binder
Temperature Viscosity Data

Variables:

- $\mu_{1,2}$ = Viscosity, in centiPoise
- G_b = Asphalt Bulk Specific Gravity, AASHTO T 228, G_b = ______
- U = $Log_{10}(Log_{10}(\mu))$
- t = $Log_{10}(T)$
- m = slope of the line
- b = Y axis intercept (Log-Log(μ))

Given Variables:

- μ_{HM} = Viscosity in centiStokes, High Mixing = 150 cSt
- μ_{LM} = Viscosity in centiStokes, Low Mixing = 190 cSt
- μ_{HC} = Viscosity in centiStokes, High Compaction = 250 cSt
- μ_{LC} = Viscosity in centiStokes, Low Compaction = 310 cSt

- U_{HM} = $Log_{10}(Log_{10}(\mu_{HM}))$, High Mixing = 0.3377
- U_{LM} = $Log_{10}(Log_{10}(\mu_{LM}))$, Low Mixing = 0.3577
- U_{HC} = $Log_{10}(Log_{10}(\mu_{HC}))$, High Compaction = 0.3798
- U_{LC} = $Log_{10}(Log_{10}(\mu_{LC}))$, Low Compaction = 0.3964

- T_1 = Test Temperature One, in Celsius = 135°C
- T_2 = Test Temperature Two, in Celsius = 160°C
- T_{K1} = Temperature, in Kelvin, 135° + 273° = 408°K
- T_{K2} = Temperature, in Kelvin, 160° + 273° = 433°K

Correction Factors:

- $CF_{135°C}$ = Viscosity Reading at 135°C = 0.9325
- $CF_{160°C}$ = Viscosity Reading at 160°C = 0.9175

Remarks:

CALCULATIONS

Variable	Calculation	Result
μ_1 cP	Rotational Viscometer Reading at 135°C, in centiPoise	cP
μ_1 cSt	μ_1 cP / (0.9325 x G_b), conversion to centiStokes	cSt
U_1	$Log_{10}(Log_{10}(\mu_1 \text{ cSt}))$	
t_1	$Log_{10}(T_{K1})$	
μ_2 cP	Rotational Viscometer Reading at 160°C, in centiPoise	cP
μ_2 cSt	μ_2 cP / (0.9175 x G_b), conversion to centiStokes	cSt
U_2	$Log_{10}(Log_{10}(\mu_2 \text{ cSt}))$	
t_2	$Log_{10}(T_{K2})$	
m	$(U_2 - U_1)/(t_2 - t_1)$	
b	U_1 - m x t_1	
T_{HM}	$10^{(0.3377 - b)/m}$ - 273°, High Mixing Temperature, in Celsius	°C
T_{LM}	$10^{(0.3577 - b)/m}$ - 273°, Low Mixing Temperature, in Celsius	°C
T_{HC}	$10^{(0.3798 - b)/m}$ - 273°, High Compaction Temperature, in Celsius	°C
T_{LC}	$10^{(0.3964 - b)/m}$ - 273°, Low Compaction Temperature, in Celsius	°C

RECOMMENDED TEMPERATURES WHEN USING MODIFIED BINDERS:

High Mixing Temperature, °C = ______
Low Mixing Temperature, °C = ______
High Compaction Temperature, °C = ______
Low Compaction Temperature, °C = ______

Initial If Using Recommended Temperatures: ______

SIGNATURE: ____________________

BR-X7M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION ______________________

ITEM ______________________

MIX TYPE ______________________

LOCATION ______________________

DESIGN NO. OF ESALs ______________________

SUPERPAVE Design Aggregate Structure Mixture Maximum Specific Gravity Summary - AASHTO T209

G_{mm} = Maximum Specific Gravity of Hot Mix Asphalt
A = Weight of dry sample in air (grams)
A' = Weight of final surface-dry sample in air (grams)
D = Weight of pycnometer filled with water at 25°C (grams)
E = Weight of pycnometer filled with sample and water at 25°C(grams)

G_{mm} = A/(A'+D-E)

	Trial Blend #1		Trial Blend #2		Trial Blend #3	
Asphalt Content	%		%		%	
Test No.	1	2	1	2	1	2
A						
A'						
D						
E						
G_{mm} = A/(A'+D-E)						
Avg. G_{mm}						

Tested by: ______________________ **Date:** ______________

BR - X8M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

SUPERPAVE Design Aggregate Structure Trial
Blend Compacted Specimen Density Worksheet

REGION ______________________

ITEM ______________________

MIX TYPE ______________________

LOCATION ______________________

DESIGN NO. OF ESAL's ______________________

							@ N-maximum				@ N-design			@ N-initial		
	Specimen	Asphalt Content %	Weight - Grams In Air	Weight - Grams In Water	Weight - Grams S.S.D.	Volume CC	Bulk Specific Gravity Gmb	Maximum Specific Gravity Gmm	% Gmm	Specimen Height mm	Specimen Height mm	Bulk Specific Gravity Gmb	% Gmm	Specimen Height mm	Bulk Specific Gravity Gmb	% Gmm
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	p	q
						e - d	c/f		100(g/h)			g X (j/k)	100(l/h)		g X (j/n)	100(p/h)
TRIAL	A															
BLEND	B															
#1	AVG.															
TRIAL	A															
BLEND	B															
#2	AVG.															
TRIAL	A															
BLEND	B															
#3	AVG															

PREPARED BY : ______________________ DATE : ______________

BR - X9M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION ____________________

ITEM ____________________

MIX TYPE ____________________

LOCATION ____________________

DESIGN NO. OF ESAL's ____________________

SUPERPAVE Design Aggregate Structure Trial Blend
Compacted Specimen Volumetric Property Summary

(Analysis by weight of total mixture)
COMPOSITION OF PAVING MIXTURE

CONSTITUENT MATERIAL		NYS DOT Source Number	Specific Gravity, G		Mix Composition, % by weight of Total Mix, P				
			Apparent	Bulk		Reg. Ver.	Trial Blend Number 1	2	3
CA	No. 3 Stone								
	No. 2 Stone				P1				
	No. 1 Stone				P2				
	No. 1 Non-Carbonate Stone				P3				
	No. 1A Stone				P4				
	No. 1A Non-Carbonate Stone				P5				
FA	Manufactured				P6				
	Natural				P7				
MINERAL FILLER					P8				
TOTAL AGGREGATE					Ps				
ASPHALT CEMENT @ 25C PG					Pb(ini)				
Gmm	Max. Sp. Gr. of Paving Mix (AASHTO T209)								
Gmb	Bulk Sp. Gr. of compacted mix @ Nmax gyrations (AASHTO T166)								
%Gmm@Nmax	%Gmm @Nmax = [(Gmb@Nmax)/(Gmm)] x 100								
Gmb @Nini	Bulk Sp. Gr. of compacted mix @ Nini gyrations								
%Gmm@Nini	%Gmm @ Nini = [(Gmb @Nini)/(Gmm)] x 100								
Gmb	Bulk Sp. Gr. of compacted mix @ Ndes gyrations								
%Gmm@Ndes	%Gmm @Ndes = [(Gmb@Ndes)/(Gmm)] x 100								
Va(@Ndes)	Va(@Ndes) = 100[(Gmm-Gmb@Ndes)/Gmm]								
Gsb	Bulk Sp. Gr. of Total aggregate*								
Gsa	Apparent Sp. Gr. of Total aggregate								
Gse	Effective Sp. Gr. of Total Aggregate Gse = [Ps] / [(100/Gmm) - (Pb/Gb)]								
VMA	VMA = 100 - (Gmb@Ndes x Ps/Gsb)								
Pb(est)	Pb(est) = Pb(ini) - {0.4 x [4 - Va(@Ndes)]}								
VMA(est)	VMA(est) = VMA + {C x [4 - Va(@Ndes)]} w/ C=0.1 if Va(@Ndes)<4 ; >4 then C=0.2								
VFB(est)	VFB(est) = 100[(VMA(est) - 4 / VMA(est)]								
Pbe	Effective asphalt content Pbe = Pb(est) - {(Ps x Gb) x [(Gse - Gsb)/(Gse x Gsb)]}								
F/Pbe (est)	Fines to Eff. AC Ratio = (% passing 0.075 mm sieve)/Pbe								
Blend Selected and Why?									

*EQUATIONS FROM NY MATERIALS METHOD 5.16

Prepared by : ____________________ Date : ____________________

BR-10M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION ______
ITEM ______
MIX TYPE ______
LOCATION ______
DESIGN NO. OF ESALs ______

SUPERPAVE Design PGB Content Mixture Maximum Specific Gravity Summary - AASHTO T209

G_{mm} = Maximum Specific Gravity of Hot Mix Asphalt
A = Weight of dry sample in air (grams)
A' = Weight of final surface-dry sample in air (grams)
D = Weight of pycnometer filled with water at 25°C (grams)
E = Weight of pycnometer filled with sample and water at 25°C(grams)

G_{mm} = A/(A'+D-E)

Asphalt Content	%		%		%		%	
Test No.	1	2	1	2	1	2	1	2
A								
A'								
D								
E								
G_{mm} = A/(A'+D-E)								
Avg. G_{mm}								

Tested by: ______ **Date:** ______

BR - 11M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

SUPERPAVE Design PGB Content Compacted

Specimen Density Worksheet

REGION ______

ITEM ______

MIX TYPE ______

LOCATION ______

DESIGN NO. OF ESAL's ______

						@ N-maximum				@ N-design			@ N-initial		
Specimen	Asphalt Content %	Weight - Grams In Air	Weight - Grams In Water	Weight - Grams S.S.D.	Volume CC	Bulk Specific Gravity Gmb	Maximum Specific Gravity Gmm	% Gmm	Specimen Height mm	Specimen Height mm	Bulk Specific Gravity Gmb	% Gmm	Specimen Height mm	Bulk Specific Gravity Gmb	% Gmm
a	b	c	d	e	f	g	h	i	j	k	l	m	n	p	q
					e - d	c/f		100(g/h)			g X (j/k)	100(l/h)		g X (j/n)	100(p/h)
A															
B															
AVG.															
A															
B															
AVG.															
A															
B															
AVG															
A															
B															
AVG.															

PREPARED BY : ______ DATE : ______

BR - 12M (2/97)

NEW YORK STATE DEPARTMENT OF TRANSPORTATION MATERIALS BUREAU

SUPERPAVE Design PGB Content
Compacted Specimen Volumetric Property Summary

(Analysis by weight of total mixture)
COMPOSITION OF PAVING MIXTURE

REGION
ITEM
MIX TYPE
LOCATION
DESIGN NO. OF ESAL's

	CONSTITUENT MATERIAL	NYS DOT Source Number	Specific Gravity, G Apparent	Specific Gravity, G Bulk	Mix Composition, % by weight of Total Mix, P	Reg. Ver.	Mix Sample Number 1	2	3	4
CA	No. 3 Stone									
	No. 2 Stone				P1					
	No. 1 Stone				P2					
	No. 1 Non-Carbonate Stone				P3					
	No. 1A Stone				P4					
	No. 1A Non-Carbonate Stone				P5					
FA	Manufactured				P6					
	Natural				P7					
MINERAL FILLER					P8					
TOTAL AGGREGATE					Ps					
ASPHALT CEMENT @ 25C PG					Pb					
Gmm	Max. Sp. Gr. of Paving Mix (AASHTO T209)									
Gmb	Bulk Sp. Gr. of compacted mix @ Nmax gyrations (AASHTO T166)									
%Gmm@Nmax	%Gmm @Nmax = [(Gmb@Nmax)/(Gmm)] x 100									
Gmb @Nini	Bulk Sp. Gr. of compacted mix @ Nini gyrations									
%Gmm@Nini	%Gmm @ Nini = [(Gmb @Nini)/(Gmm)] x 100									
Gmb	Bulk Sp. Gr. of compacted mix @ Ndes gyrations									
%Gmm@Ndes	%Gmm @Ndes = [(Gmb@Ndes)/(Gmm)] x 100									
Va(@Ndes)	Va(@Ndes) = 100[(Gmm-Gmb@Ndes)/Gmm]									
Gsb	Bulk Sp. Gr. of Total aggregate*									
Gsa	Apparent Sp. Gr. of Total aggregate									
Gse	Effective Sp. Gr. of Total Aggregate Gse = [Ps] / [(100/Gmm) - (Pb/Gb)]									
VMA	VMA = 100 - (Gmb@Ndes x Ps/Gsb)									
VFB	VFB = [(VMA - Va)/VMA] x 100									
Pbe	Pbe = Pb - [(Ps x Gb) x {(Gse - Gsb)/(Gse x Gsb)}]									
F/Pbe	Fines to Eff. AC Ratio = (% passing 0.075 mm sieve)/Pbe									

Remarks :

*EQUATIONS FROM NY MATERIALS METHOD 5.16

Prepared by : ____________ Date : ____________

BR - 13M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION ____________________

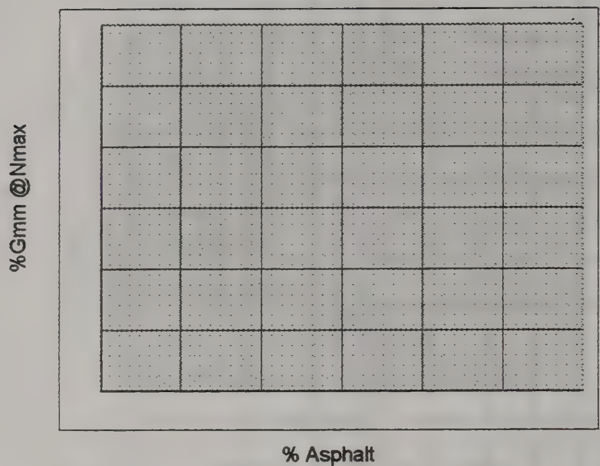
ITEM ____________________

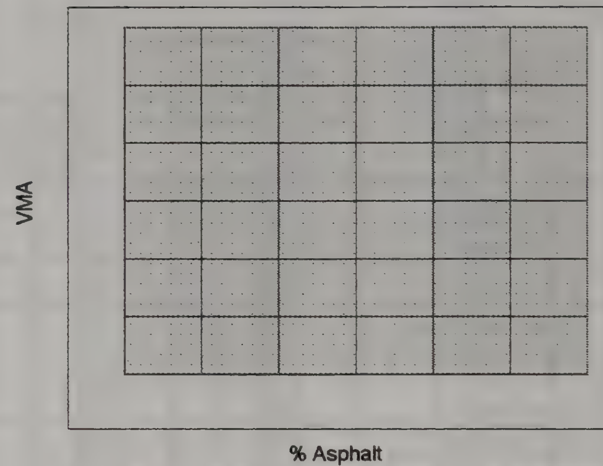
MIX TYPE ____________________

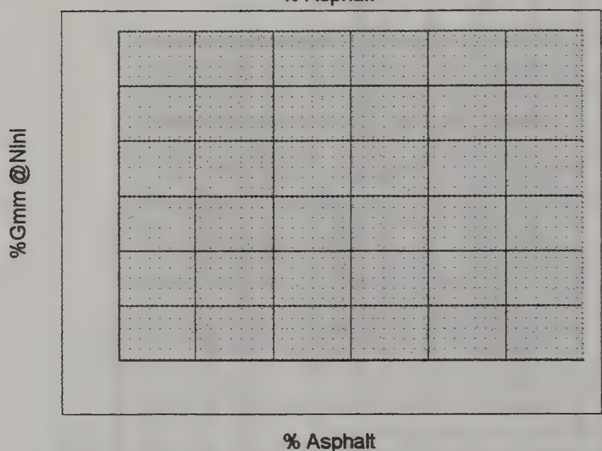
LOCATION ____________________

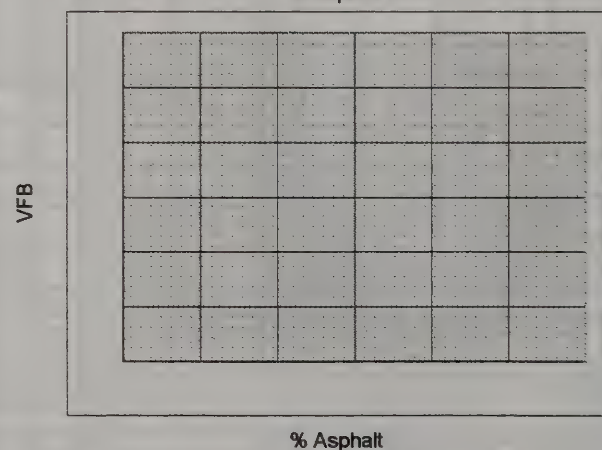
DESIGN NO. OF ESAL's ____________________

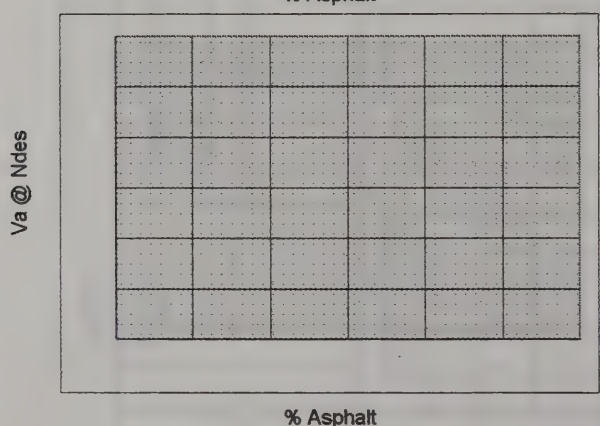
SUPERPAVE VOLUMETRIC PROPERTY CURVES

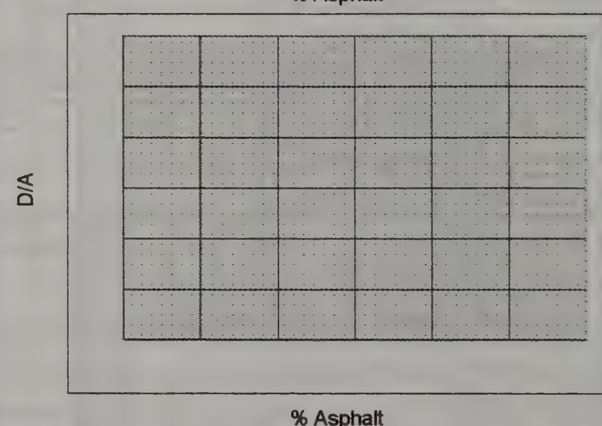












VALUES AT OPTIMUM AC CONTENT

Property	%Gmm @Nmax	% Gmm @Nini	@ Ndes Va, %	@ Ndes VMA, %	@ Ndes VFB, %	@ Ndes D/A
Specs.	<98%	<89%	4%			0.6-1.2
Actual						

Optimum AC Content __________ **Submitted By** ____________________ **Date** __________

BR - 14M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION ______________________

ITEM ______________________

MIX TYPE ______________________

LOCATION ______________________

DESIGN NO. OF ESAL's ______________________

SUPERPAVE BATCH WEIGHTS FOR MIXTURE VERIFICATION

COMBINED SUPERPAVE(GYRATORY SAMPLE) GRADATION AT THE % ASPHALT CEMENT INDICATED

%	AGGREGATE	%	GRAMS	WEIGHT RETAINED (GRAMS)													TOTAL
AC	COMPONENT	BATCH	BATCH	50.0 mm	37.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	PAN	WT. RET.
	Mineral Filler																
	TOTAL																

(specimen wtg) = ________ X ________ % AC = ________ gr. AC

(specimen wtg) = ________ - ________ gr. AC = ________ gr. Aggregate

COMBINED SUPERPAVE(MAXIMUM SPECIFIC GRAVITY SAMPLE) GRADATION AT THE % ASPHALT CEMENT INDICATED

%	AGGREGATE	%	GRAMS	WEIGHT RETAINED (GRAMS)													TOTAL
AC	COMPONENT	BATCH	BATCH	50.0 mm	37.5 mm	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	1.18 mm	0.600 mm	0.300 mm	0.150 mm	0.075 mm	PAN	WT. RET.
	Mineral Filler																
	TOTAL																

(specimen wtg) = ________ X ________ % AC = ________ gr. AC

(specimen wtg) = ________ - ________ gr. AC = ________ gr. Aggregate

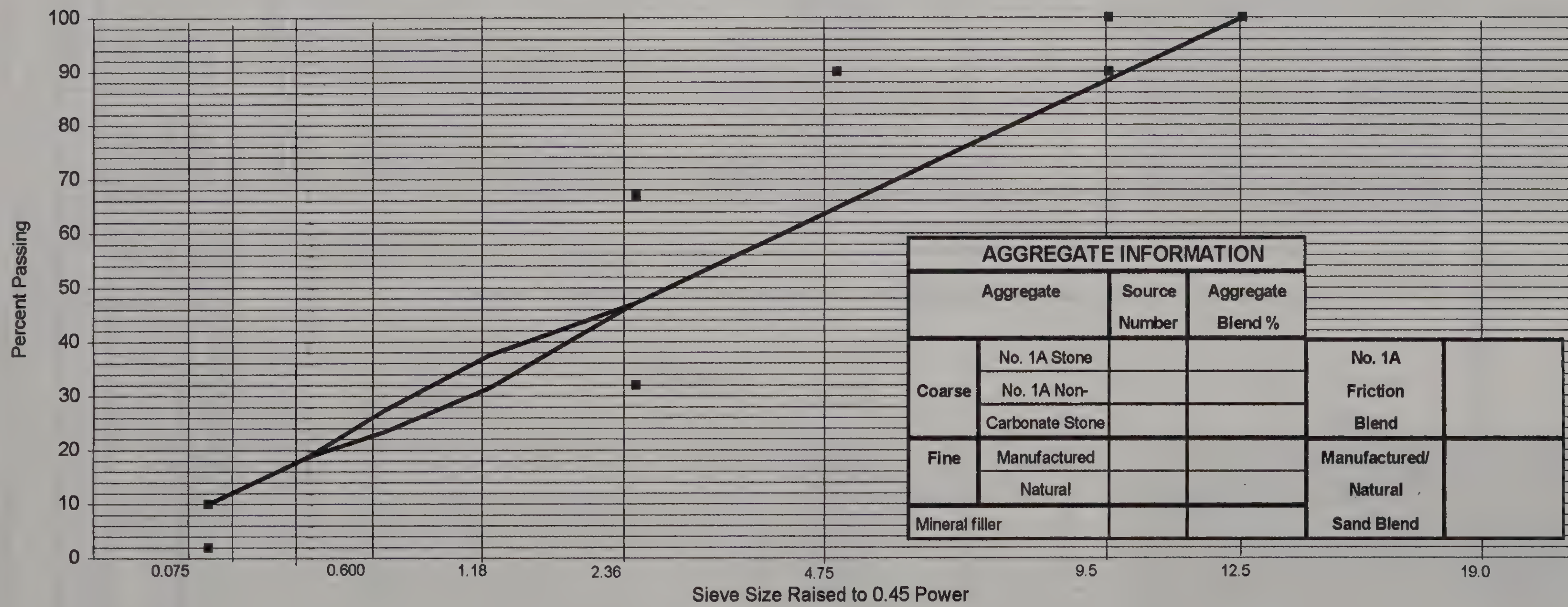
TESTED BY : ______________________ ON : ____________

BR - 15M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION ____________ ITEM ____________
JMF NO. ____________
MIX TYPE ____________
PRODUCER ____________
LOCATION ____________
DESIGN NO. OF ESAL's ____________

SUPERPAVE Job Mix Formula - 9.5 mm Nom. Size



AGGREGATE INFORMATION					
Aggregate		Source Number	Aggregate Blend %		
Coarse	No. 1A Stone			No. 1A Friction Blend	
	No. 1A Non-				
	Carbonate Stone				
Fine	Manufactured			Manufactured/ Natural Sand Blend	
	Natural				
Mineral filler					

Sieve Size		0.075 mm	0.150 mm	0.300 mm	0.600 mm	1.18 mm	2.36 mm	4.75 mm	9.5 mm	12.5 mm	19.0 mm	% Asphalt	Asphalt Grade
% Passing	General Limits	2 - 10					32 - 67	<90	90 - 100	100			PG -
	JMF Range												
	Target Value												

Recommended for Review by Regional Director ____________ Date : ____________

Remarks : ____________

Revised

BR - 15M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION ______________________ ITEM ______________________

JMF NO. ______________________

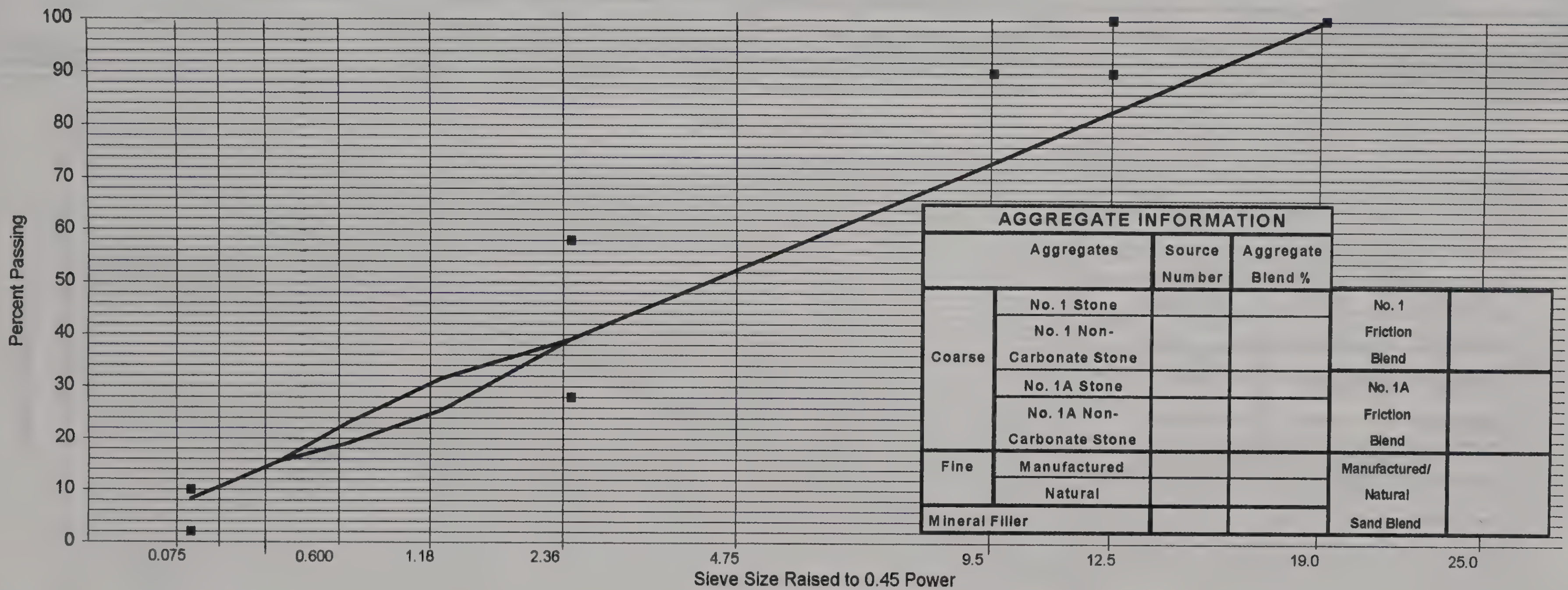
MIX TYPE ______________________

PRODUCER ______________________

LOCATION ______________________

DESIGN NO. OF ESAL's ______________________

SUPERPAVE Job Mix Formula - 12.5 mm Nom. Size



AGGREGATE INFORMATION			
	Aggregates	Source Number	Aggregate Blend %
Coarse	No. 1 Stone		
	No. 1 Non-Carbonate Stone		
	No. 1A Stone		
	No. 1A Non-Carbonate Stone		
Fine	Manufactured		
	Natural		
Mineral Filler			

No. 1 Friction Blend	
No. 1A Friction Blend	
Manufactured/ Natural Sand Blend	

Sieve Size		0.075 mm	0.150 mm	0.300 mm	0.600 mm	1.18 mm	2.36 mm	4.75 mm	9.5 mm	12.5 mm	19.0 mm	25.0 mm	% Asphalt	Asphalt Grade
% Passing	General Limits	2 - 10					28-58		<90	90-100	100			PG -
	JMF Range													
	Target Value													

Recommended for Review by Regional Director ______________________ Date: __________

Remarks : ____

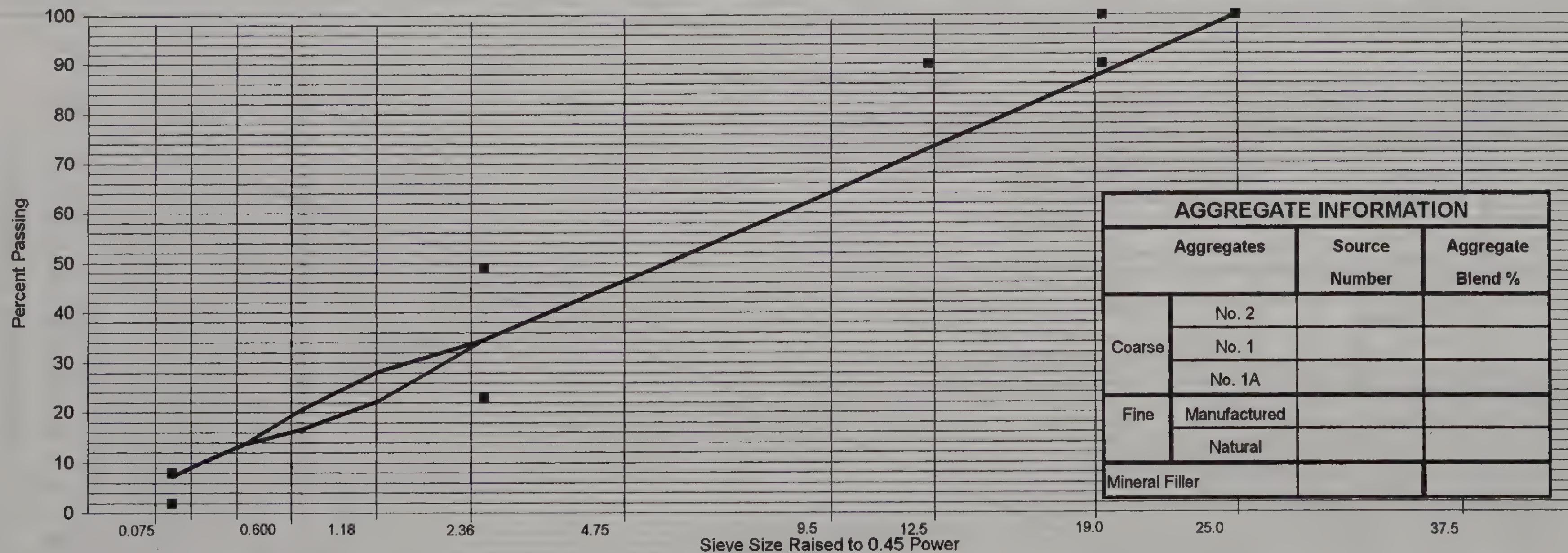
Revised

BR - 15M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION ______ ITEM ______
JMF NO. ______
MIX TYPE ______
PRODUCER ______
LOCATION ______
DESIGN NO. OF ESAL's ______

SUPERPAVE Job Mix Formula - 19.0 mm Nom. Size



AGGREGATE INFORMATION			
Aggregates		Source Number	Aggregate Blend %
Coarse	No. 2		
	No. 1		
	No. 1A		
Fine	Manufactured		
	Natural		
Mineral Filler			

Sieve Size		0.075 mm	0.150 mm	0.300 mm	0.600 mm	1.18 mm	2.36 mm	4.75 mm	9.5 mm	12.5 mm	19.0 mm	25.0 mm	37.5 mm	% Asphalt	Asphalt Grade
% Passing	General Limits	2-8					23-49			<90	90-100	100			PG -
	JMF Range														
	Target Value														

Recommended for Review by Regional Director ______ Date : ______

Remarks : ______

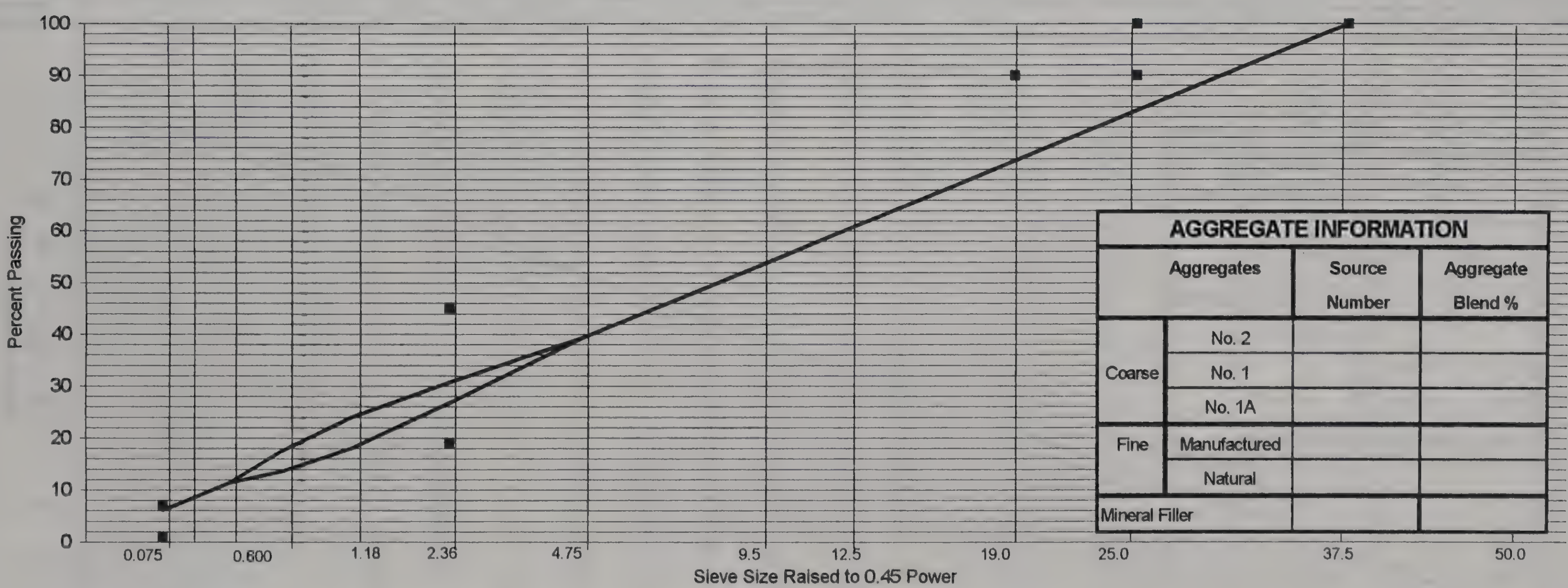
Revised

BR - 15M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION ______ ITEM ______
JMF NO. ______
MIX TYPE ______
PRODUCER ______
LOCATION ______
DESIGN NO. OF ESAL's ______

SUPERPAVE Job Mix Formula - 25.0 mm Nom. Size



AGGREGATE INFORMATION

	Aggregates	Source Number	Aggregate Blend %
Coarse	No. 2		
	No. 1		
	No. 1A		
Fine	Manufactured		
	Natural		
Mineral Filler			

Sieve Size		0.075 mm	0.150 mm	0.300 mm	0.600 mm	1.18 mm	2.36 mm	4.75 mm	9.5 mm	12.5 mm	19.0 mm	25.0 mm	37.5 mm	50.0 mm	% Asphalt	Asphalt Grade
% Passing	General Limits	1-7					19-45				<90	90-100	100			PG -
	JMF Range															
	Target Value															

Recommended for Review by Regional Director ______ Date : ______

Remarks : ______

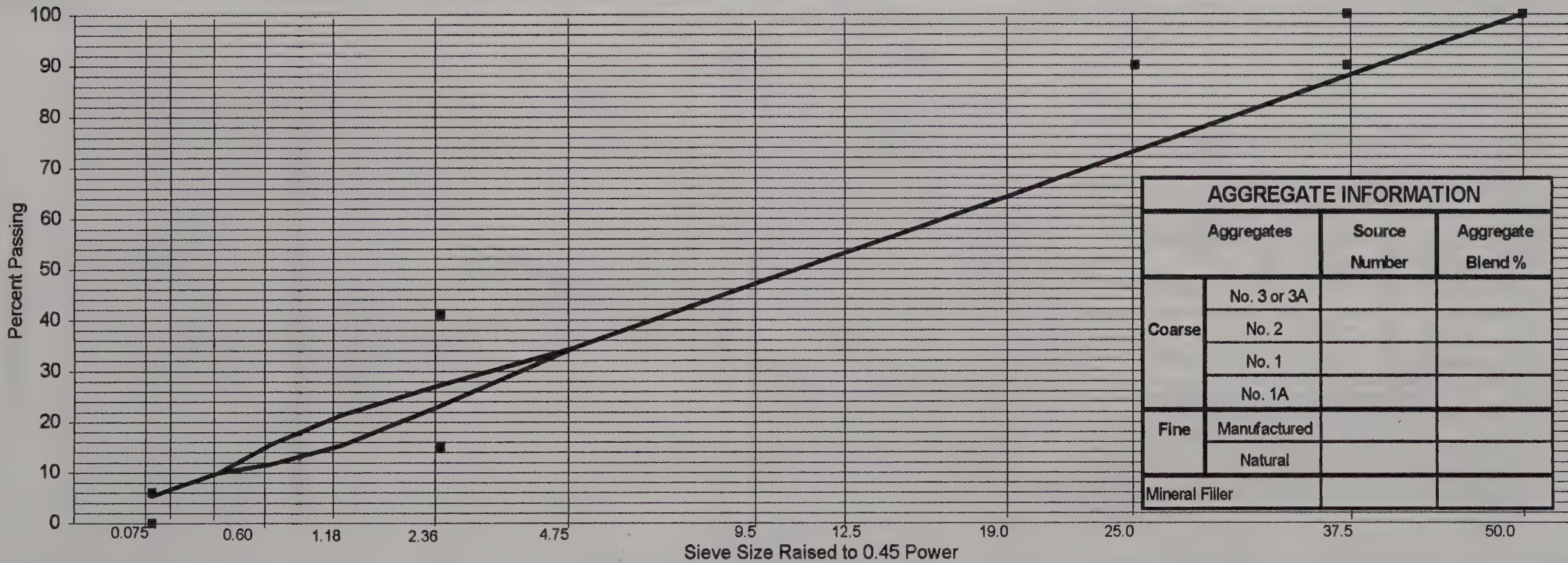
Revised

BR - 15M (2/97)

NEW YORK STATE
DEPARTMENT OF TRANSPORTATION
MATERIALS BUREAU

REGION	ITEM
JMF NO.	
MIX TYPE	
PRODUCER	
LOCATION	
DESIGN NO. OF ESAL's	

SUPERPAVE Job Mix Formula - 37.5 mm Nom. Size



AGGREGATE INFORMATION			
Aggregates		Source Number	Aggregate Blend %
Coarse	No. 3 or 3A		
	No. 2		
	No. 1		
	No. 1A		
Fine	Manufactured		
	Natural		
Mineral Filler			

Sieve Size		0.075 mm	0.150 mm	0.300 mm	0.600 mm	1.18 mm	2.36 mm	4.75 mm	9.5 mm	12.5 mm	19.0 mm	25.0 mm	37.5 mm	50.0 mm	% Asphalt	Asphalt Grade
% Passing	General Limits	0-6					15-41					<90	90-100	100		PG -
	JMF Range															
	Target Value															

Recommended for Review by Regional Director : __________ Date : ______

Remarks : __________

Revised

APPENDIX 5

SUPERPAVE DEFINITION OF TERMS

JMF	=	job mix formula
G_{mb}	=	bulk specific gravity of compacted mixture
G_{mm}	=	maximum specific gravity of bituminous mixture
V_a	=	air voids in compacted mixture, % of total volume
VMA	=	voids in mineral aggregate (% of bulk volume)
VFB	=	% of voids in the mineral aggregate filled with effective performance graded binder
P_{be}	=	effective performance graded binder content, percent by total weight of mixture
G_{sb}	=	bulk specific gravity for the total aggregate
G_{sa}	=	apparent specific gravity for the total aggregate
G_{se}	=	effective specific gravity for the total aggregate
G_n	=	bulk or apparent (whichever is applicable) specific gravities of aggregates
G_b	=	specific gravity of performance graded binder, at 25°C
P	=	% total SUPERPAVE Hot Mix Asphalt mixture by weight = 100%
P_b	=	performance graded binder, percent by total weight of mixture
P_s	=	aggregate, percent by total weight of mixture
P_n	=	% of individual aggregate components, based on total weight of aggregate
SHMA	=	SUPERPAVE Hot Mix Asphalt
PGB	=	performance graded binder
$P_{0.075\ mm}/P_{be}$	=	minus 0.075 mm aggregate to the effective PGB content ratio

EAQ	=	estimated total aggregate consensus property quality
AQ_N	=	aggregate consensus property quality
$PP(R)_N$	=	percentage passing or percentage retained for the specified sieve size for each stockpile
PB_N	=	blend proportions for each stockpile
PGBW	=	total performance graded binder batch weight
TABW	=	total aggregate batch weight
TWA	=	total weight of aggregate batched
TSW	=	total specimen weight
QAF	=	quantity adjustment factor

NOTES

EAQ = estimated total aggregate consensus property quality

AQ_b = aggregate consensus property quality

PP/R_{s} = percentage passing or percentage retained for the specified sieve size for each stockpile

BP_{s} = blend proportions for each stockpile

PGBW = total performance graded binder batch weight

TABW = total aggregate batch weight

TWA = total weight of aggregates batched

TSW = total specimen weight

QAF = quantity adjustment factor